TITLE: MULTI-PAIR GIGABIT ETHERNET TRANSCEIVER HAVING ADAPTIVE ...
INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

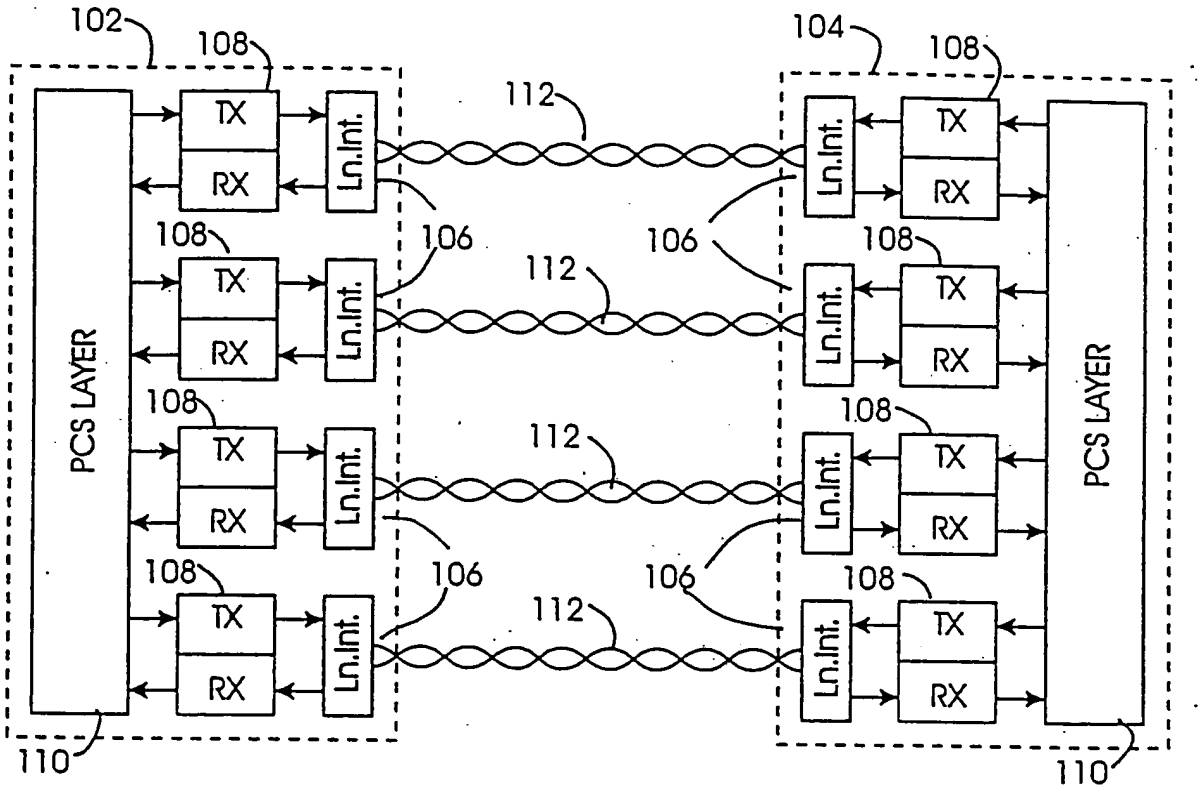

FIG. 1

TITLE: MULTI-PAIR GIGABIT ETHERNET TRANSCEIVER HAVING ADAPTIVE ...
INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

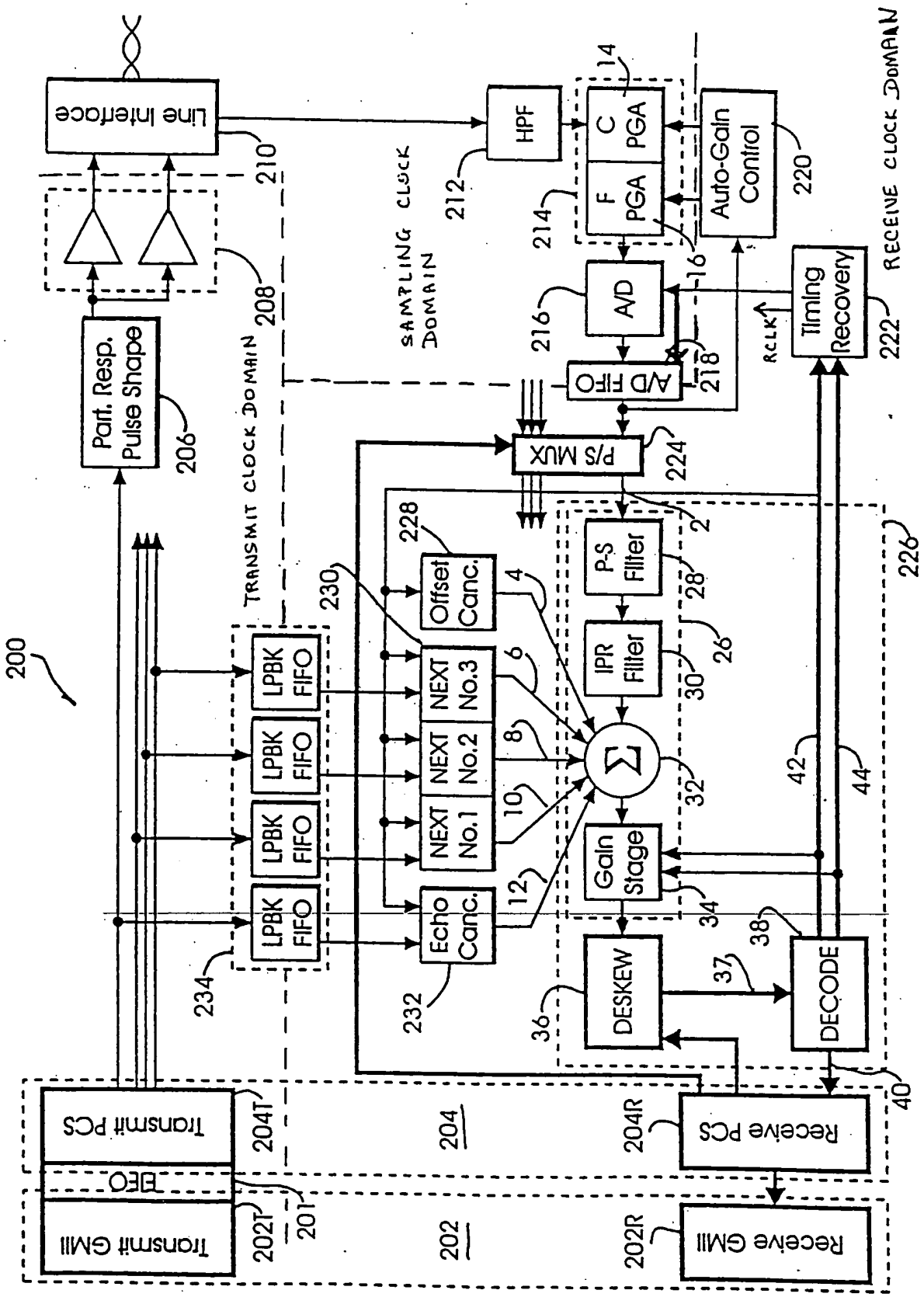

FIG. 2

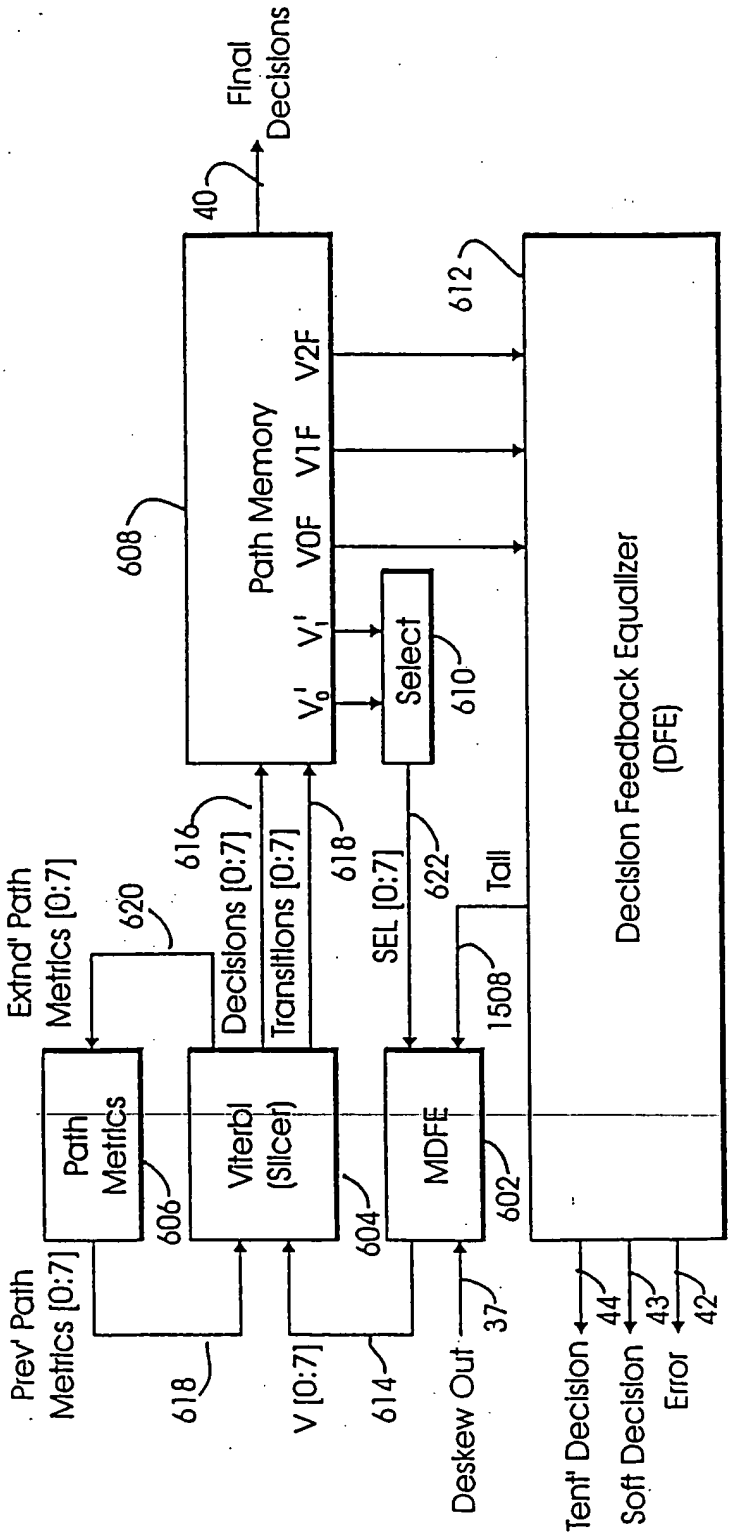
Final Decisions
40
612
608
Path Memory
V2F
V1F
V0F
V1'
V0'
Select
610
616
618
622
Tail
1508
Decision Feedback Equalizer (DFE)
Extnd' Path Metrics [0:7]
620
Decisions [0:7]
Transitions [0:7]
SEL [0:7]
Path Metrics
606
Viterbi (Slicer)
604
MDFE
602
Prev' Path Metrics [0:7]
618
V [0:7]
614
Deskew Out
37
Tent' Decision
44
Soft Decision
43
Error
42

FIG. 3

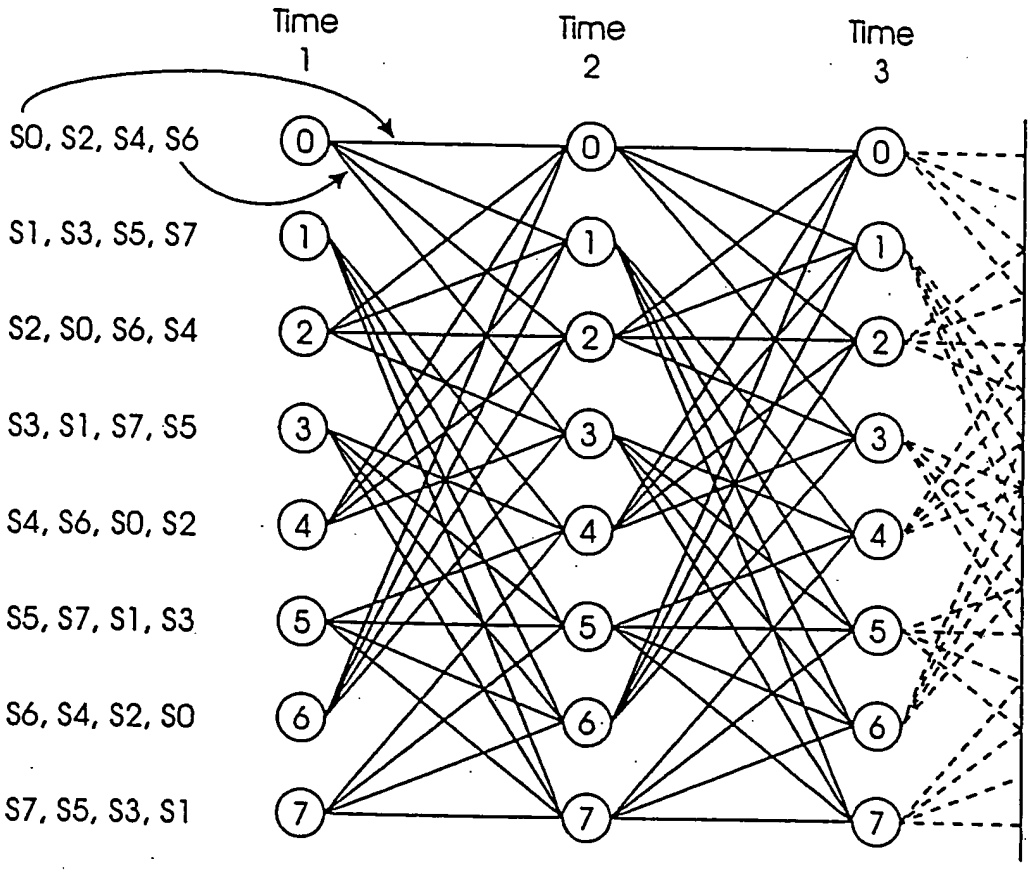
Time 1
Time 2
Time 3
S0, S2, S4, S6
S1, S3, S5, S7
S2, S0, S6, S4
S3, S1, S7, S5
S4, S6, S0, S2
S5, S7, S1, S3
S6, S4, S2, S0
S7, S5, S3, S1
0
1
2
3
4
5
6
7

FIG. 5

TITLE: MULTI-PAIR GIGABIT ETHERNET
TRANSCEIVER HAVING ADAPTIVE ...
INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

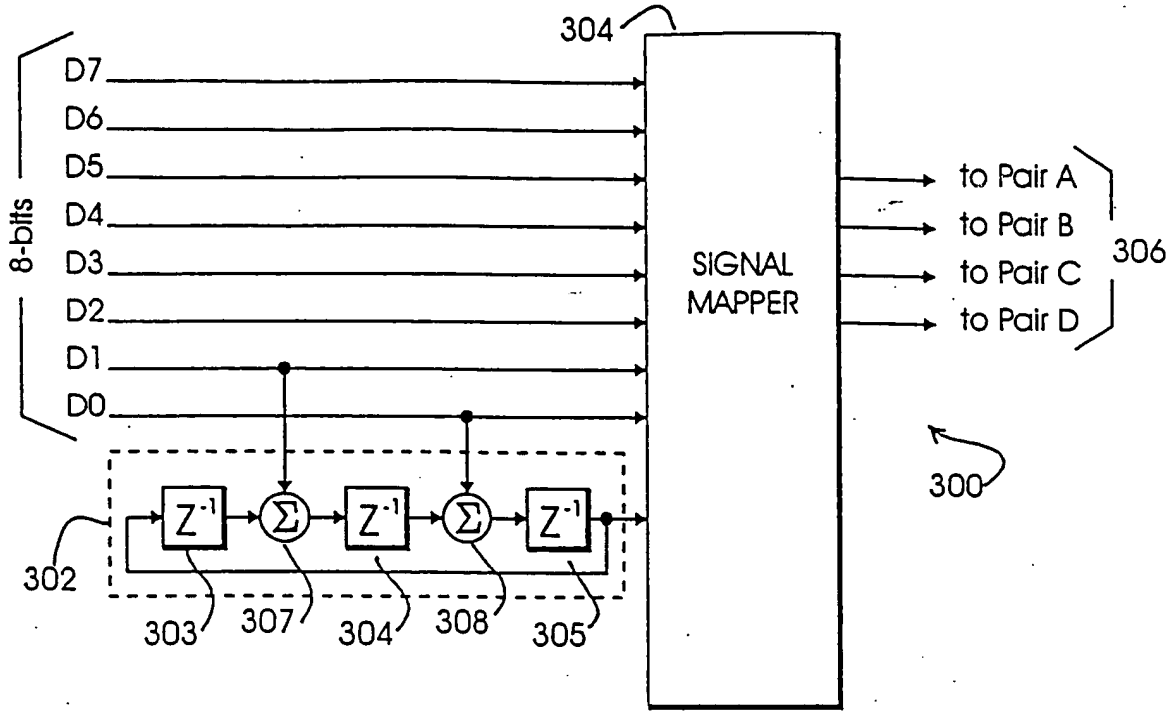

FIG. 6

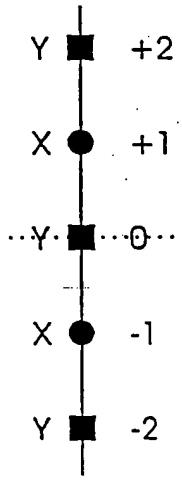

FIG. 4A

	Pair ABCD		Pair ABCD
s0	XXXX	U	YYYY
s1	XXXY	U	YYYX
s2	XXYY	U	YYXX
s3	XXYX	U	YYXY
s4	XYYX	U	YXXY
s5	XYYY	U	YXXX
s6	XYXY	U	YXYX
s7	XYXX	U	YXYY

FIG. 4B

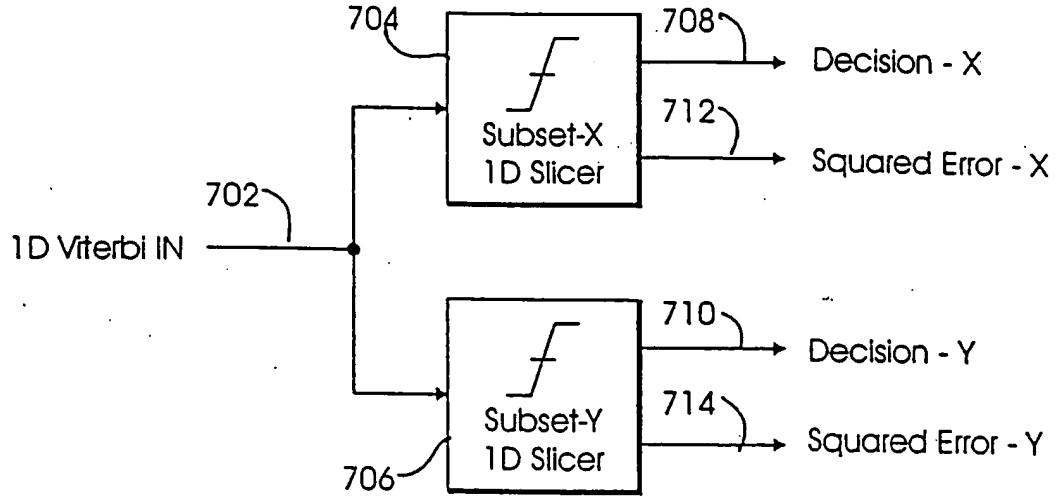
704
708
Decision - X
712
Squared Error - X
Subset-X
1D Slicer
702
1D Viterbi IN
710
Decision - Y
714
Squared Error - Y
Subset-Y
1D Slicer
706

FIG. 7

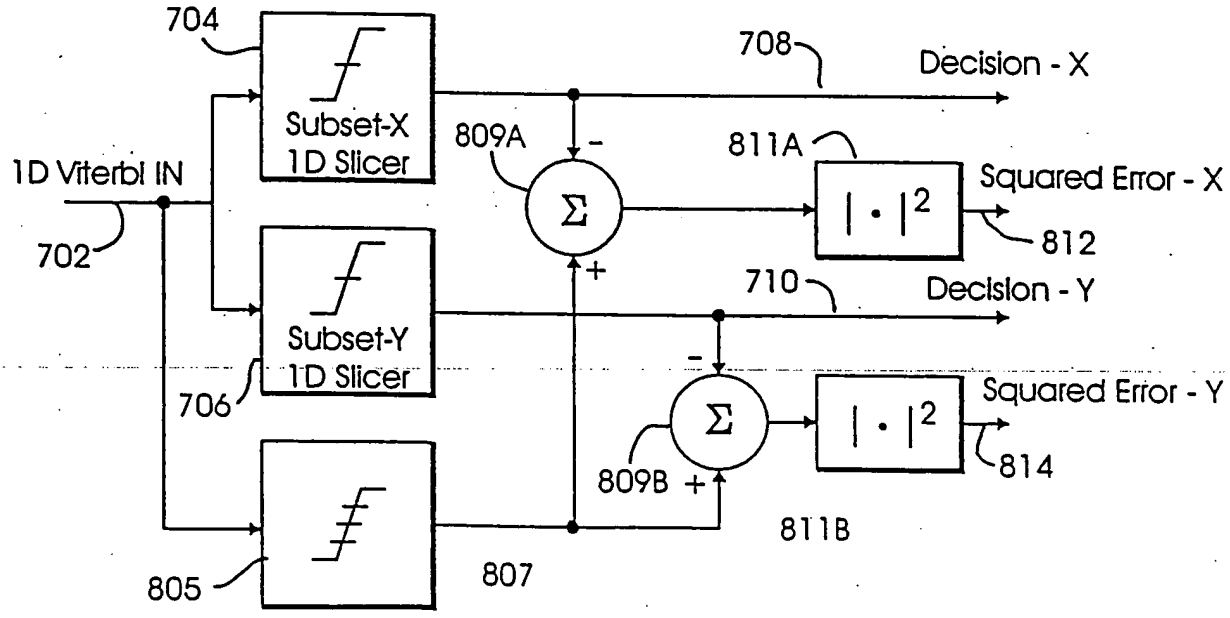
704
708
Decision - X
Subset-X
1D Slicer
809A
811A
Squared Error - X
1D Viterbi IN
702
812
710
Decision - Y
Subset-Y
1D Slicer
706
Squared Error - Y
809B
814
811B
805
807

FIG. 8

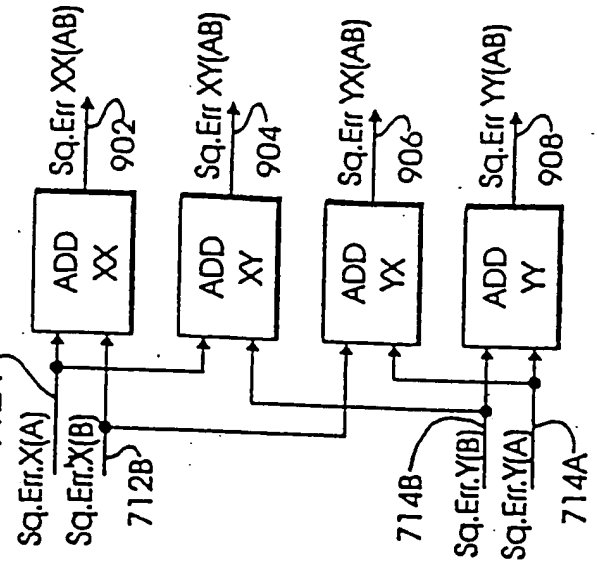
Sq.Err XX(AB)
902
Sq.Err XY(AB)
904
Sq.Err YX(AB)
906
Sq.Err YY(AB)
908
ADD XX
ADD XY
ADD YX
ADD YY
712A
Sq.Err.X(A)
Sq.Err.X(B)
712B
714B
Sq.Err.Y(B)
Sq.Err.Y(A)
714A

FIG. 9

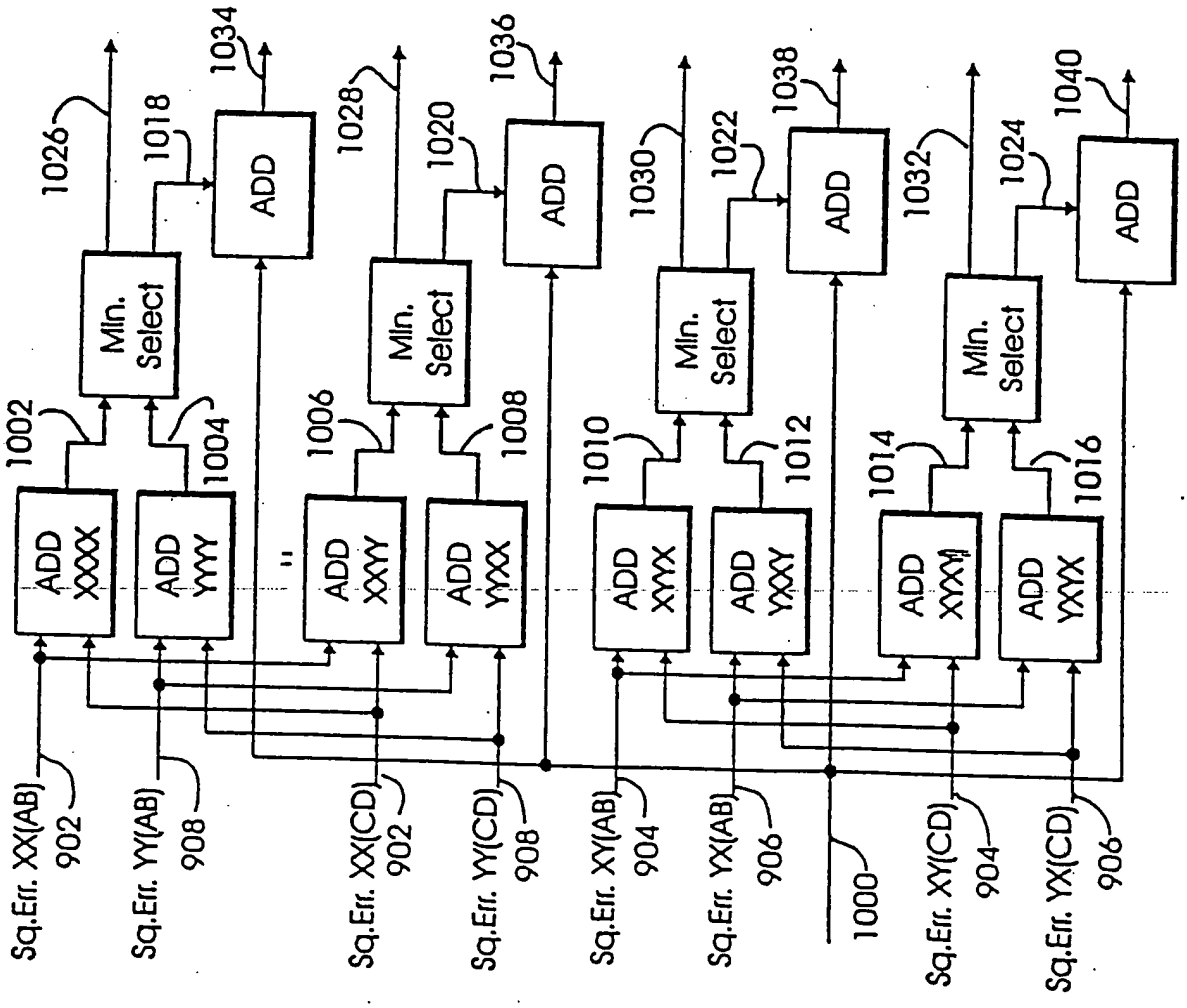
Sq.Err. XX(AB) 902
Sq.Err. YY(AB) 908
Sq.Err. XX(CD) 902
Sq.Err. YY(CD) 908
Sq.Err. XY(AB) 904
Sq.Err. YX(AB) 906
Sq.Err. XY(CD) 904
Sq.Err. YX(CD) 906
1000
ADD XXXX
ADD YYY
ADD XXYY
ADD YYXX
ADD XYYX
ADD YXXY
ADD XYXM
ADD YXYX
1002
1004
1006
1008
1010
1012
1014
1016
Min. Select
1018
1020
1022
1024
ADD
1026
1028
1030
1032
1034
1036
1038
1040

FIG. 10

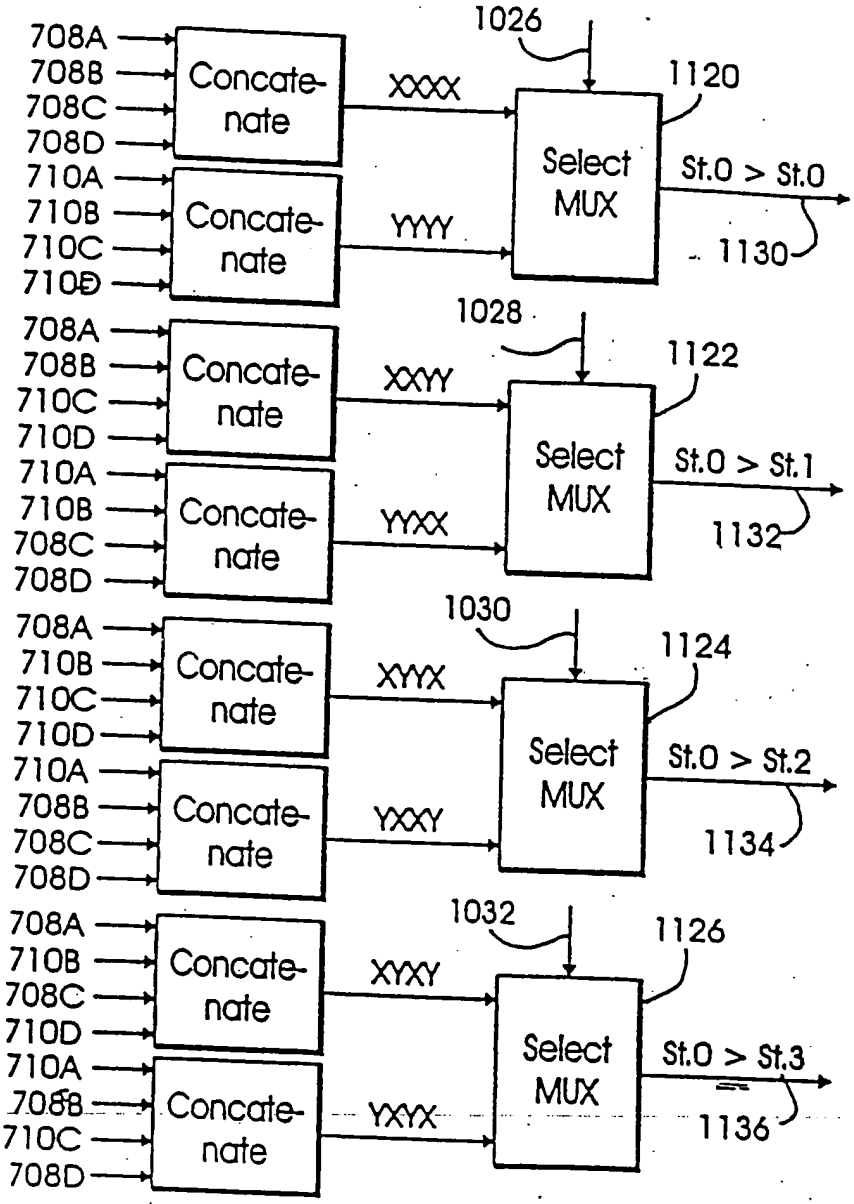
708A
708B
708C
708D
710A
710B
710C
710D
Concate-nate
Concate-nate
XXXX
YYYY
1026
Select MUX
1120
St.0 > St.0
1130
708A
708B
710C
710D
710A
710B
708C
708D
Concate-nate
Concate-nate
XXYY
YYXX
1028
Select MUX
1122
St.0 > St.1
1132
708A
710B
710C
710D
710A
708B
708C
708D
Concate-nate
Concate-nate
XYYX
YXXY
1030
Select MUX
1124
St.0 > St.2
1134
708A
710B
708C
710D
710A
708B
710C
708D
Concate-nate
Concate-nate
XYXY
YXYX
1032
Select MUX
1126
St.0 > St.3
1136

FIG. 11

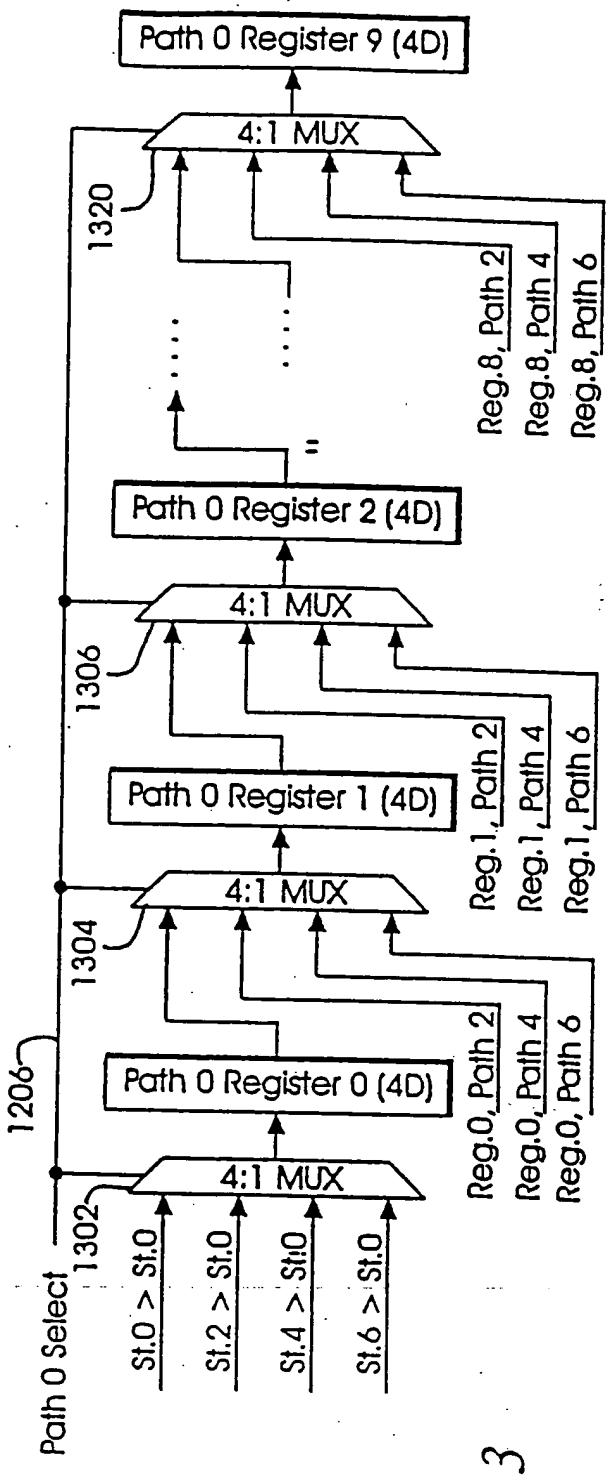
Path 0 Register 9 (4D)
4:1 MUX
1320
Reg.8, Path 2
Reg.8, Path 4
Reg.8, Path 6
Path 0 Register 2 (4D)
4:1 MUX
1306
Reg.1, Path 2
Reg.1, Path 4
Reg.1, Path 6
Path 0 Register 1 (4D)
4:1 MUX
1304
Reg.0, Path 2
Reg.0, Path 4
Reg.0, Path 6
1206
Path 0 Register 0 (4D)
4:1 MUX
1302
Path 0 Select
St.0 > St.0
St.2 > St.0
St.4 > St.0
St.6 > St.0

FIG. 13

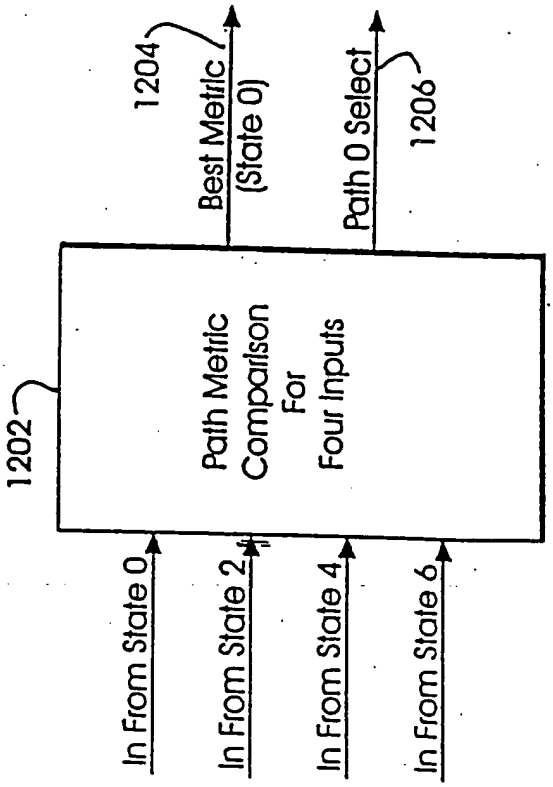
1204
Best Metric
(State 0)
Path 0 Select
1206
1202
Path Metric
Comparison
For
Four Inputs
In From State 0
In From State 2
In From State 4
In From State 6

FIG. 12

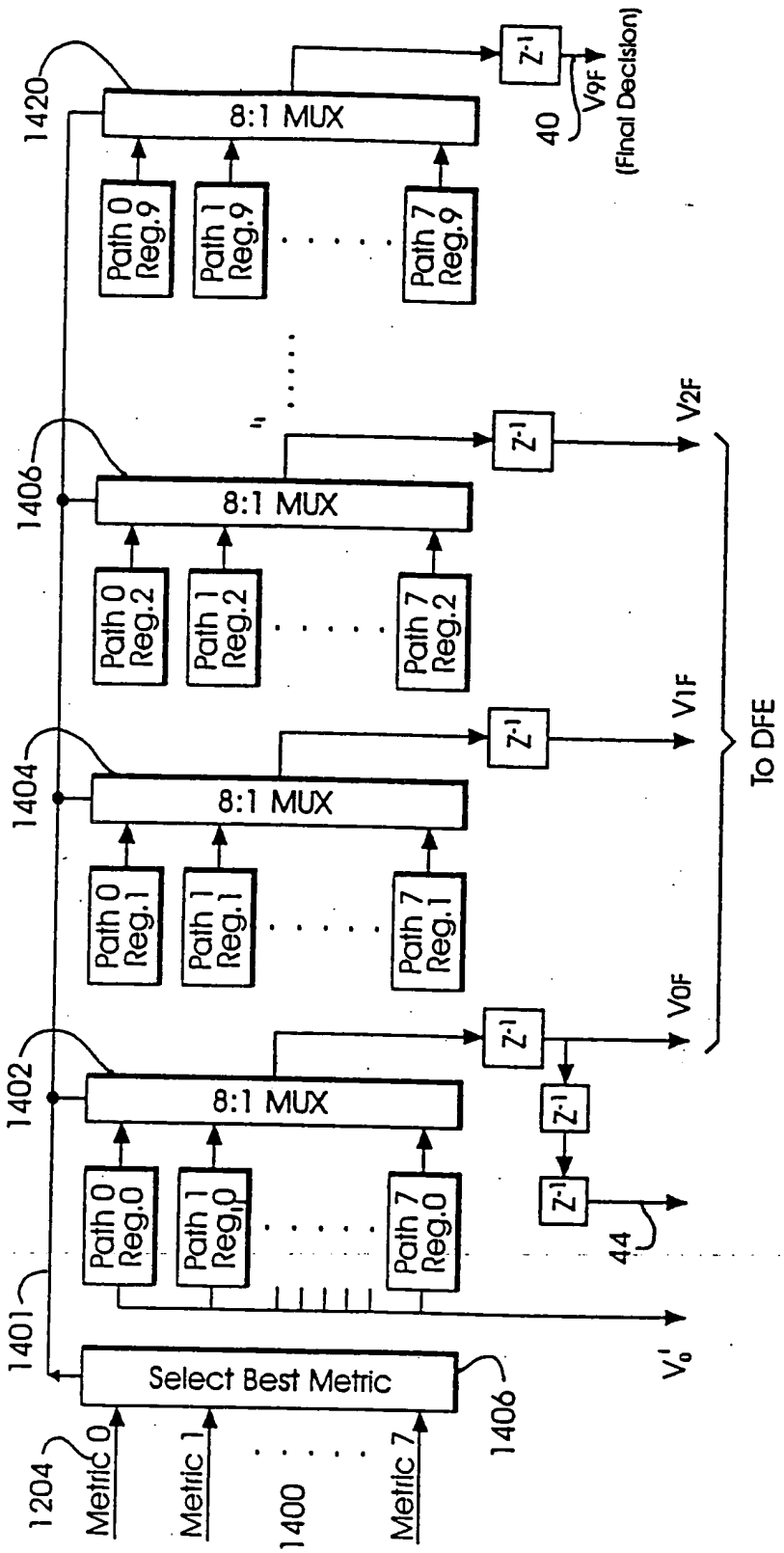
1420
8:1 MUX
Path 0 Reg.9
Path 1 Reg.9
Path 7 Reg.9
Z-1
V9F
(Final Decision)
40
1406
8:1 MUX
Path 0 Reg.2
Path 1 Reg.2
Path 7 Reg.2
Z-1
V2F
1404
8:1 MUX
Path 0 Reg.1
Path 1 Reg.1
Path 7 Reg.1
Z-1
V1F
1402
8:1 MUX
Path 0 Reg.0
Path 1 Reg.0
Path 7 Reg.0
Z-1
V0F
Z-1
Z-1
44
To DFE
1401
Select Best Metric
1406
V0'
1204
Metric 0
Metric 1
Metric 7
1400

FIG. 14

TITLE: MULTI-PAIR GIGABIT ETHERNET TRANSCEIVER HAVING ADAPTIVE ...
INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

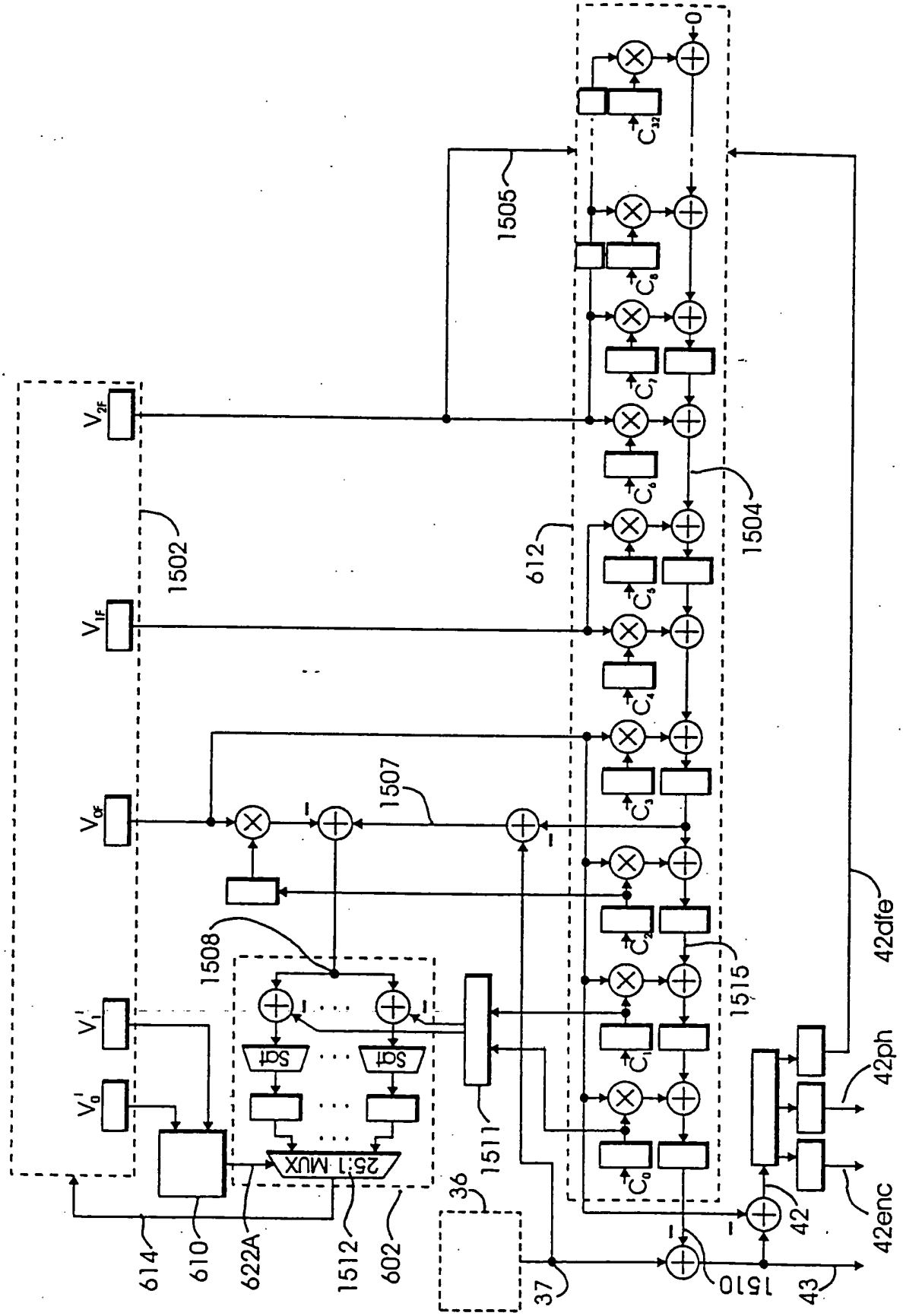

FIG. 15

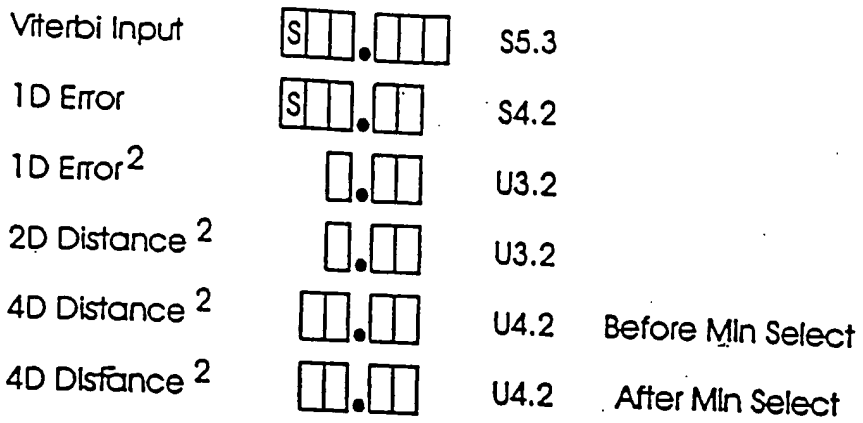

FIG. 16

Error Values	1D Distance² Values
00.00	0.00
00.01 / 11.11	0.00
00.10 / 11.10	0.01
00.11 / 11.01	0.10
01.00 / 11.00	1.00

FIG. 17

FIG. 18A

VITERBIINPUT	DECISION X	ERROR X	ROUNDEDERROR X	ERROR X**2	DECISION Y	ERROR Y	ROUNDEDERROR Y	ERROR Y**2
01.111	001	00.111	01.00	1.00	010	11.111	00.00	0.00
01.110	001	00.110	00.11	0.10	010	11.110	11.11	0.00
01.101	001	00.101	00.11	0.10	010	11.101	11.11	0.00
01.100	001	00.100	00.10	0.01	010	11.100	11.10	0.01
01.011	001	00.011	00.10	0.01	010	11.011	11.10	0.01
01.010	001	00.010	00.01	0.00	010	11.010	11.01	0.10
01.001	001	00.001	00.01	0.00	010	11.001	11.01	0.10
01.000	001	00.000	00.00	0.00	010	11.000	11.00	1.00
00.111	001	11.111	00.00	0.00	000	00.111	01.00	1.00
00.110	001	11.110	11.11	0.00	000	00.110	00.11	0.10
00.101	001	11.101	11.11	0.00	000	00.101	00.11	0.10
00.100	001	11.100	11.10	0.01	000	00.100	00.10	0.01
00.011	001	11.011	11.10	0.01	000	00.011	00.10	0.01
00.010	001	11.010	11.01	0.10	000	00.010	00.01	0.00
00.001	001	11.001	11.01	0.10	000	00.001	00.01	0.00
00.000	001	11.000	11.00	1.00	000	00.000	00.00	0.00

TITLE: MULTI-PAIR GIGABIT ETHERNET TRANSCEIVER HAVING ADAPTIVE ...
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ATTORNEY: JAW, PHONE: 312-775-8000

FIG. 18B

VITERBIINPUT	DECISION X	ERROR X	ROUNDEDERROR X	ERROR X**2	DECISION Y	ERROR Y	ROUNDEDERROR Y	ERROR Y**2
11.111	111	00.111	01.00	1.00	000	11.111	00.00	0.00
11.110	111	00.110	00.11	0.10	000	11.110	11.11	0.00
11.101	111	00.101	00.11	0.10	000	11.101	11.11	0.00
11.100	111	00.100	00.10	0.01	000	11.100	11.10	0.01
11.011	111	00.011	00.10	0.01	000	11.011	11.10	0.01
11.010	111	00.010	00.01	0.00	000	11.010	11.01	0.10
11.001	111	00.001	00.01	0.00	000	11.001	11.01	0.10
11.000	111	00.000	00.00	0.00	000	11.000	11.00	1.00
10.111	111	11.111	00.00	0.00	110	00.111	01.00	1.00
10.110	111	11.110	11.11	0.00	110	00.110	00.11	0.10
10.101	111	11.101	11.11	0.00	110	00.101	00.11	0.10
10.100	111	11.100	11.10	0.01	110	00.100	00.10	0.01
10.011	111	11.011	11.10	0.01	110	00.011	00.10	0.01
10.010	111	11.010	11.01	0.10	110	00.010	00.01	0.00
10.001	111	11.001	11.01	0.10	110	00.001	00.01	0.00
10.000	111	11.000	11.00	1.00	110	00.000	00.00	0.00

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INVENTOR: AGAZZI
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ATTORNEY: JAW, PHONE: 312-775-8000

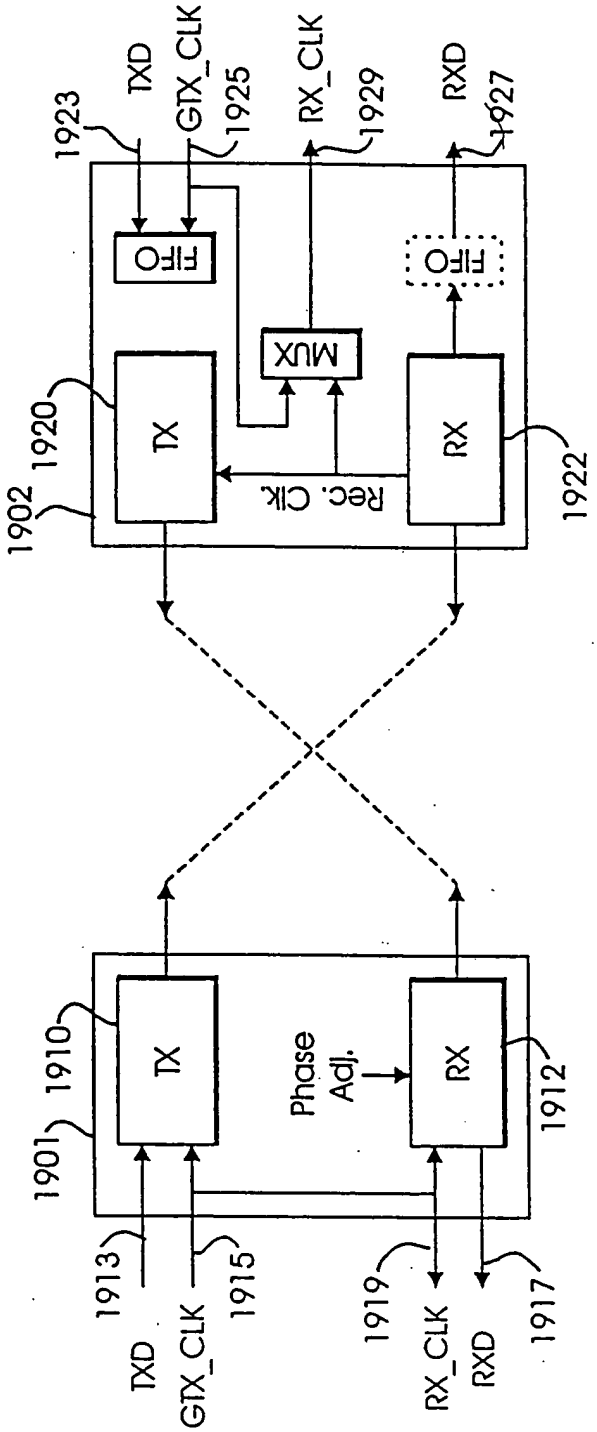
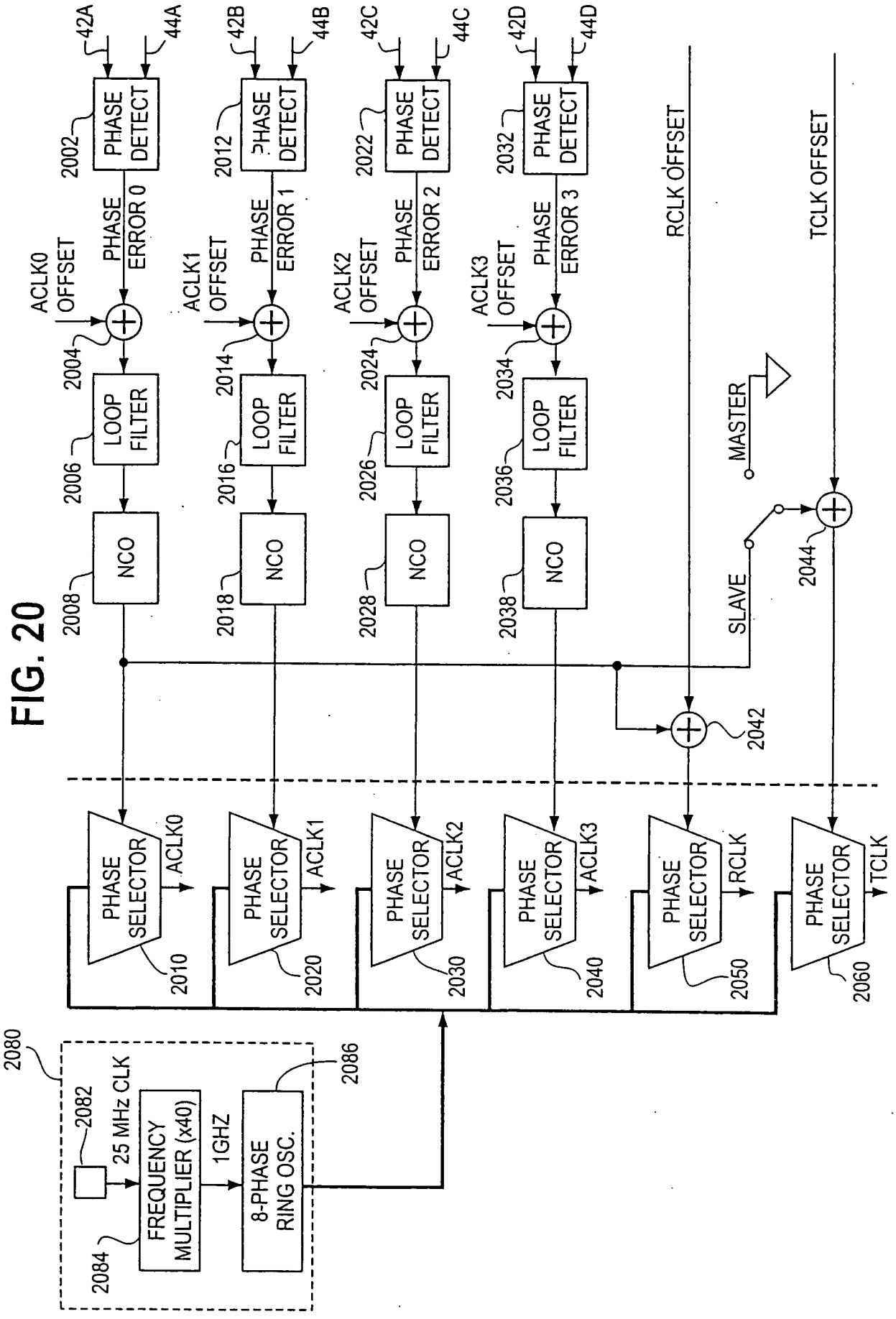

1923
TXD
GTX_CLK
1925
RX_CLK
1929
RXD
1927
FIFO
FIFO
MUX
TX
RX
Rec. Clk.
1920
1902
1922
1910
1901
TX
Phase
Adj.
RX
1912
1913
1915
1919
1917
TXD
GTX_CLK
RX_CLK
RXD

FIG. 19

TITLE: MULTI-PAIR GIGABIT ETHERNET TRANSCEIVER HAVING ADAPTIVE ...
INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

FIG. 20



TITLE: MULTI-PAIR GIGABIT ETHERNET
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INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

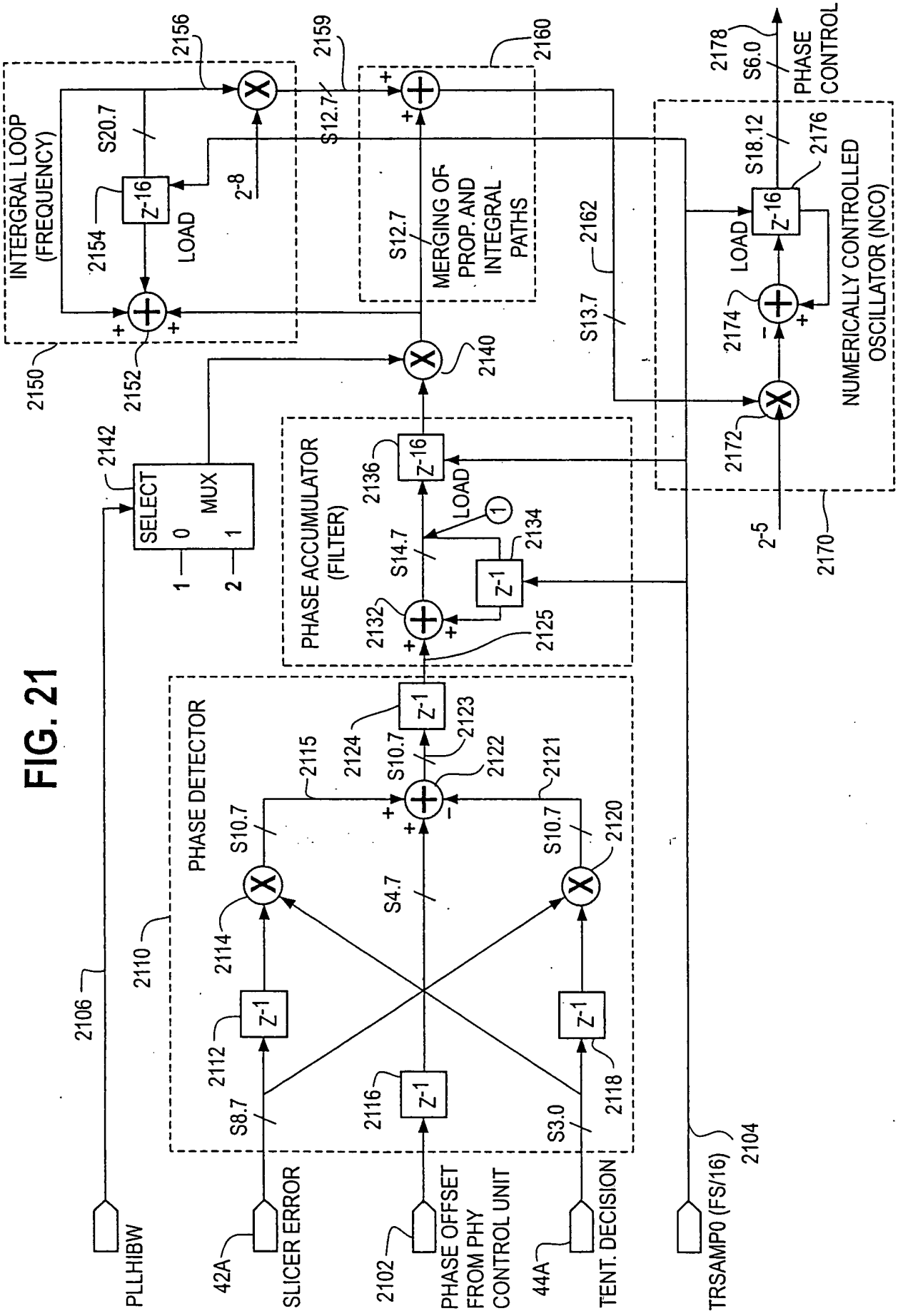


FIG. 21

FIG. 22

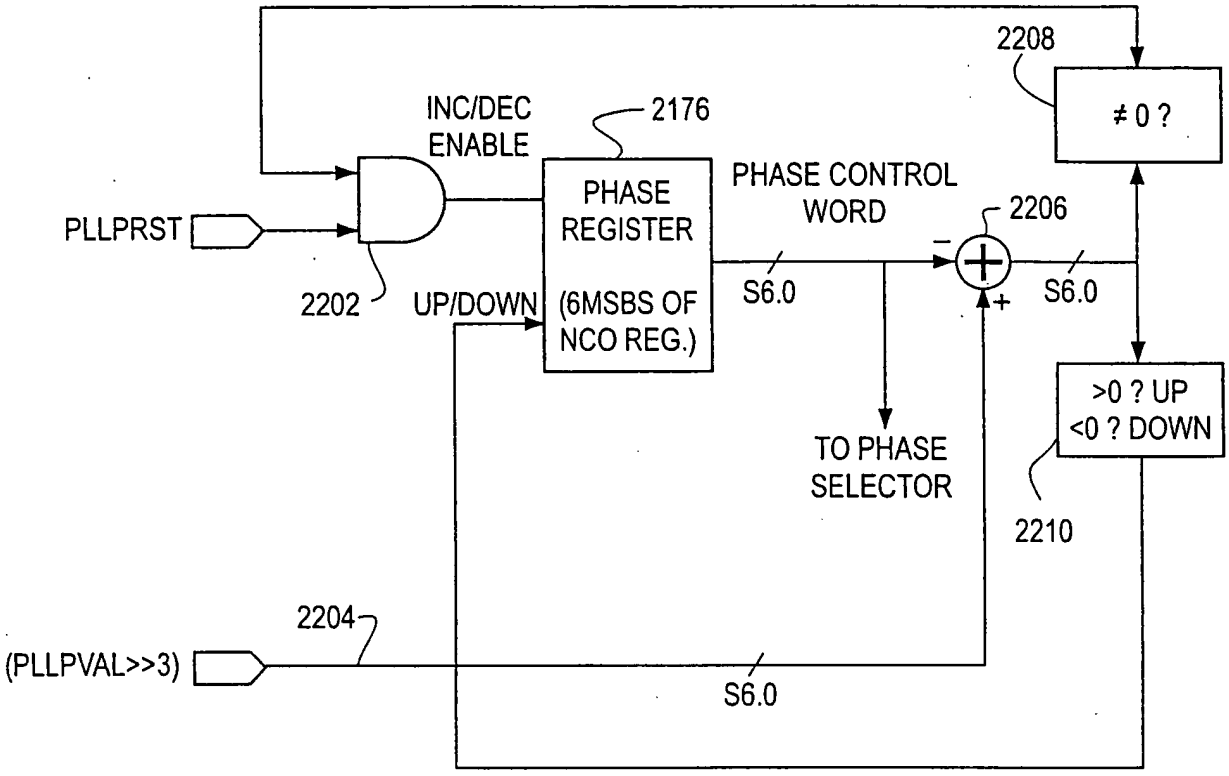

2208
≠ 0 ?
INC/DEC
ENABLE
2176
PHASE
REGISTER
(6MSBS OF
NCO REG.)
PHASE CONTROL
WORD
2206
PLLPRST
2202
UP/DOWN
S6.0
S6.0
>0 ? UP
<0 ? DOWN
TO PHASE
SELECTOR
2210
2204
(PLLPVAL>>3)
S6.0

FIG. 23

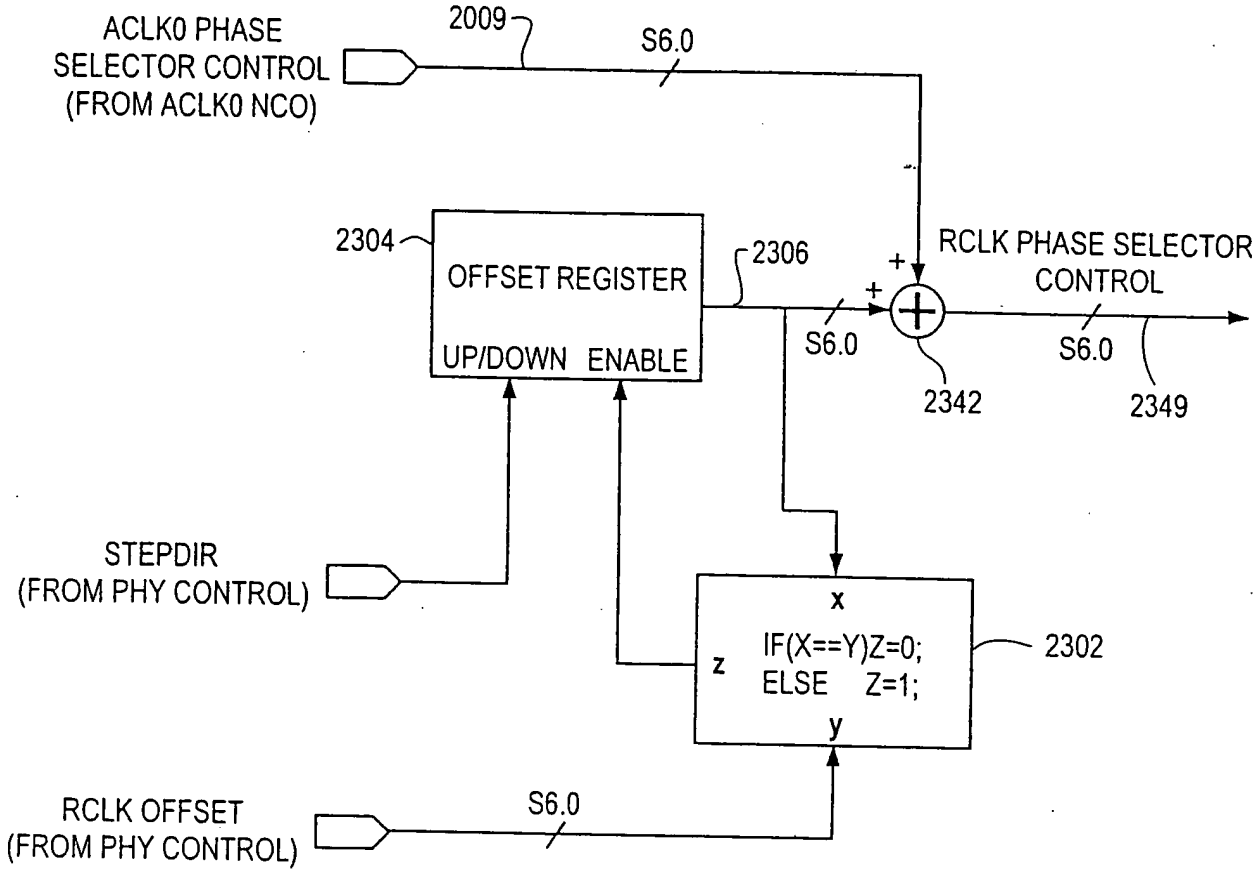

ACLK0 PHASE
SELECTOR CONTROL
(FROM ACLK0 NCO)
2009
S6.0
2304
OFFSET REGISTER
UP/DOWN ENABLE
2306
+
+
S6.0
2342
RCLK PHASE SELECTOR
CONTROL
S6.0
2349
STEPDIR
(FROM PHY CONTROL)
x
z
IF(X==Y)Z=0;
ELSE Z=1;
y
2302
RCLK OFFSET
(FROM PHY CONTROL)
S6.0

FIG. 24A

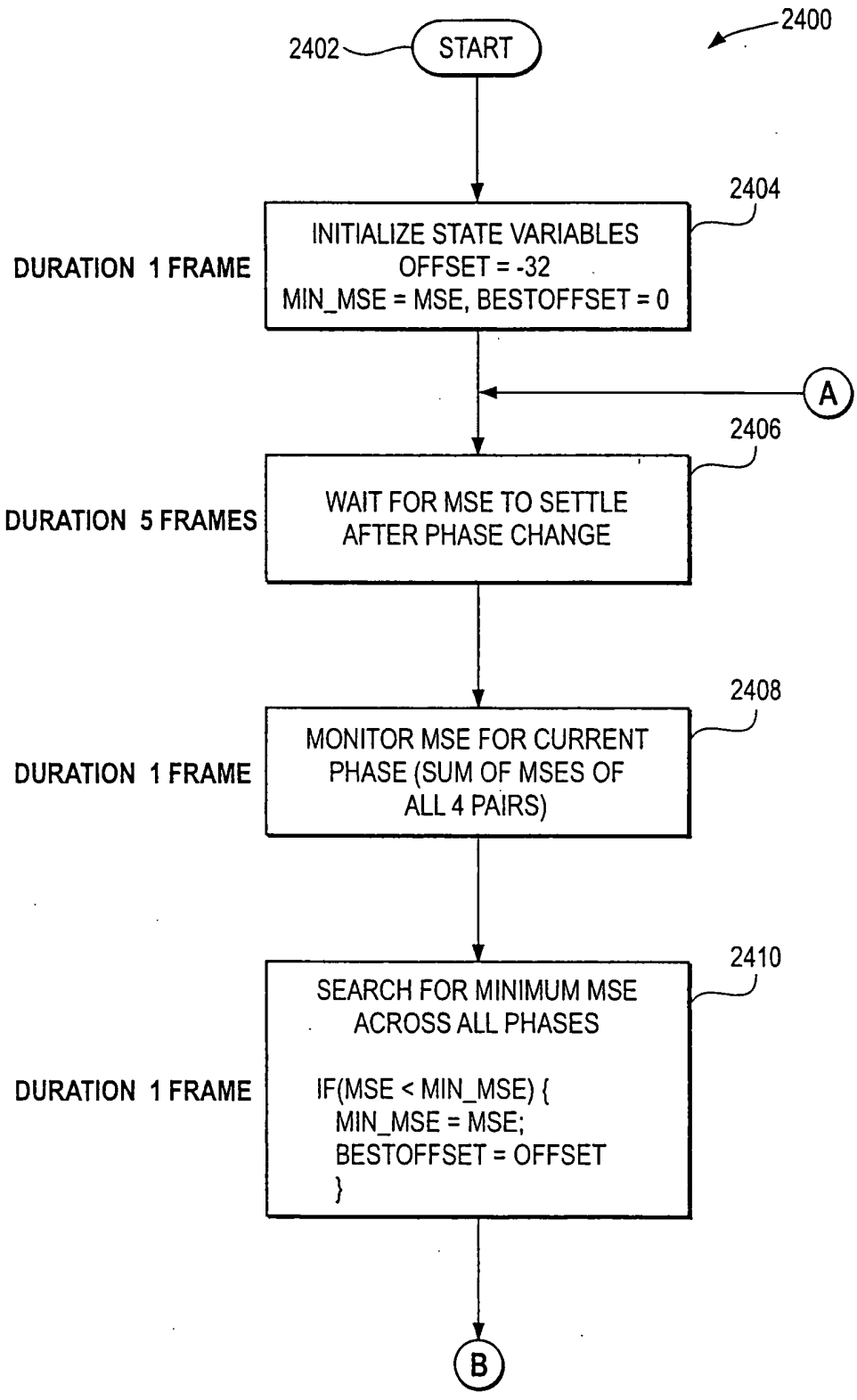

2400
2402
START
2404
INITIALIZE STATE VARIABLES
OFFSET = -32
MIN_MSE = MSE, BESTOFFSET = 0
DURATION 1 FRAME
A
2406
WAIT FOR MSE TO SETTLE
AFTER PHASE CHANGE
DURATION 5 FRAMES
2408
MONITOR MSE FOR CURRENT
PHASE (SUM OF MSES OF
ALL 4 PAIRS)
DURATION 1 FRAME
2410
SEARCH FOR MINIMUM MSE
ACROSS ALL PHASES
IF(MSE < MIN_MSE) {
MIN_MSE = MSE;
BESTOFFSET = OFFSET
}
DURATION 1 FRAME
B

FIG. 24B

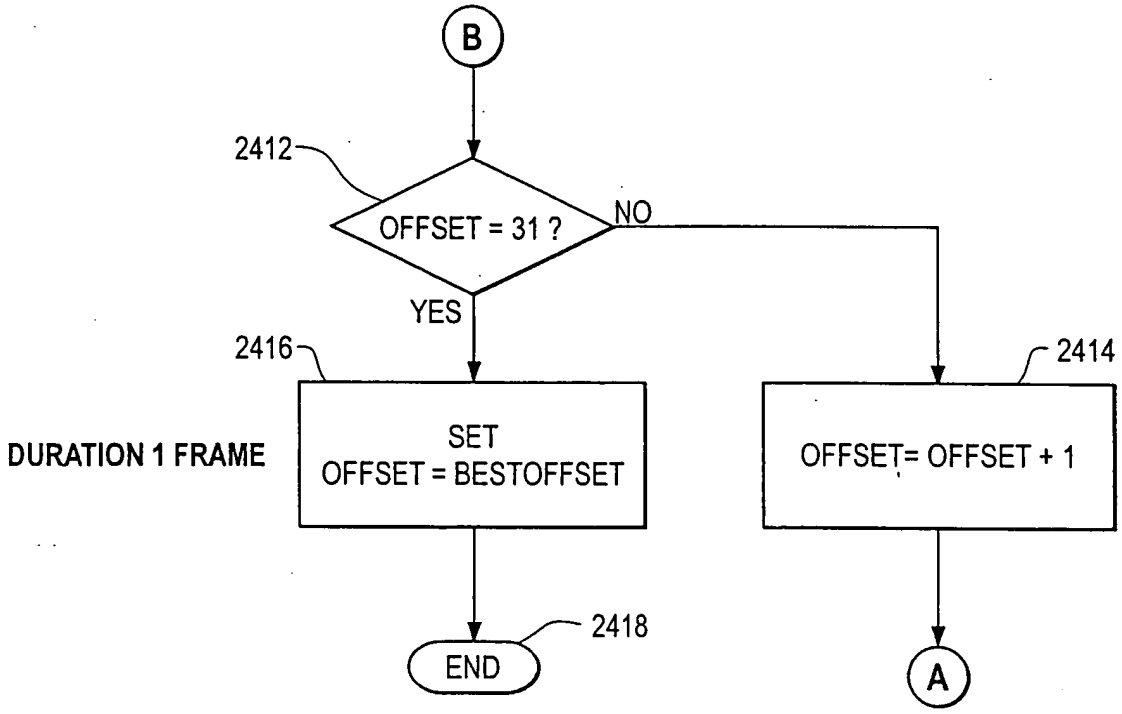

B
2412
OFFSET = 31 ?
NO
YES
2416
2414
DURATION 1 FRAME
SET
OFFSET = BESTOFFSET
OFFSET= OFFSET + 1
2418
END
A

FIG. 25A

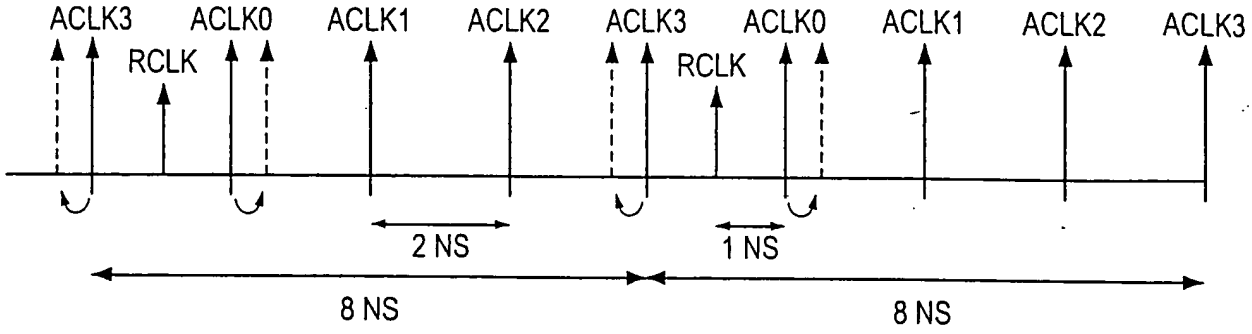


FIG. 25B

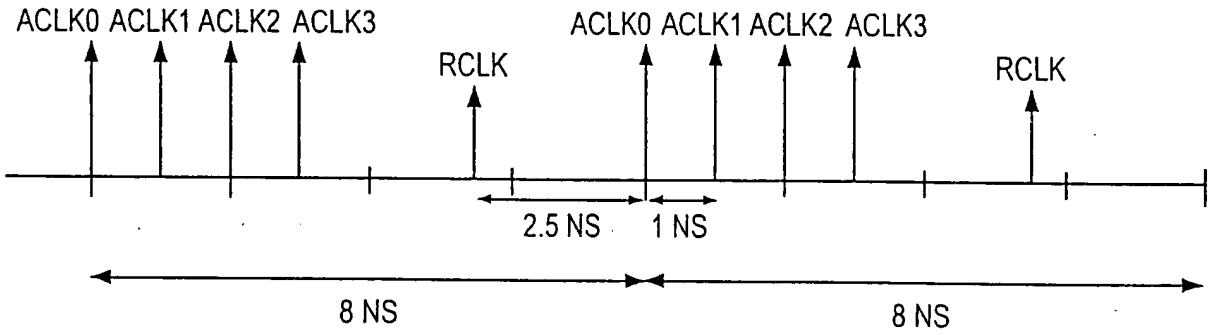


FIG. 25C

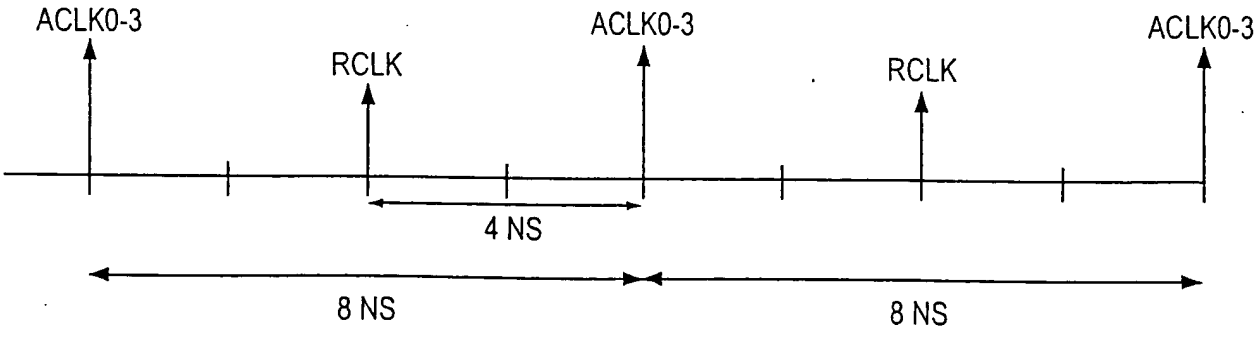


FIG. 26A

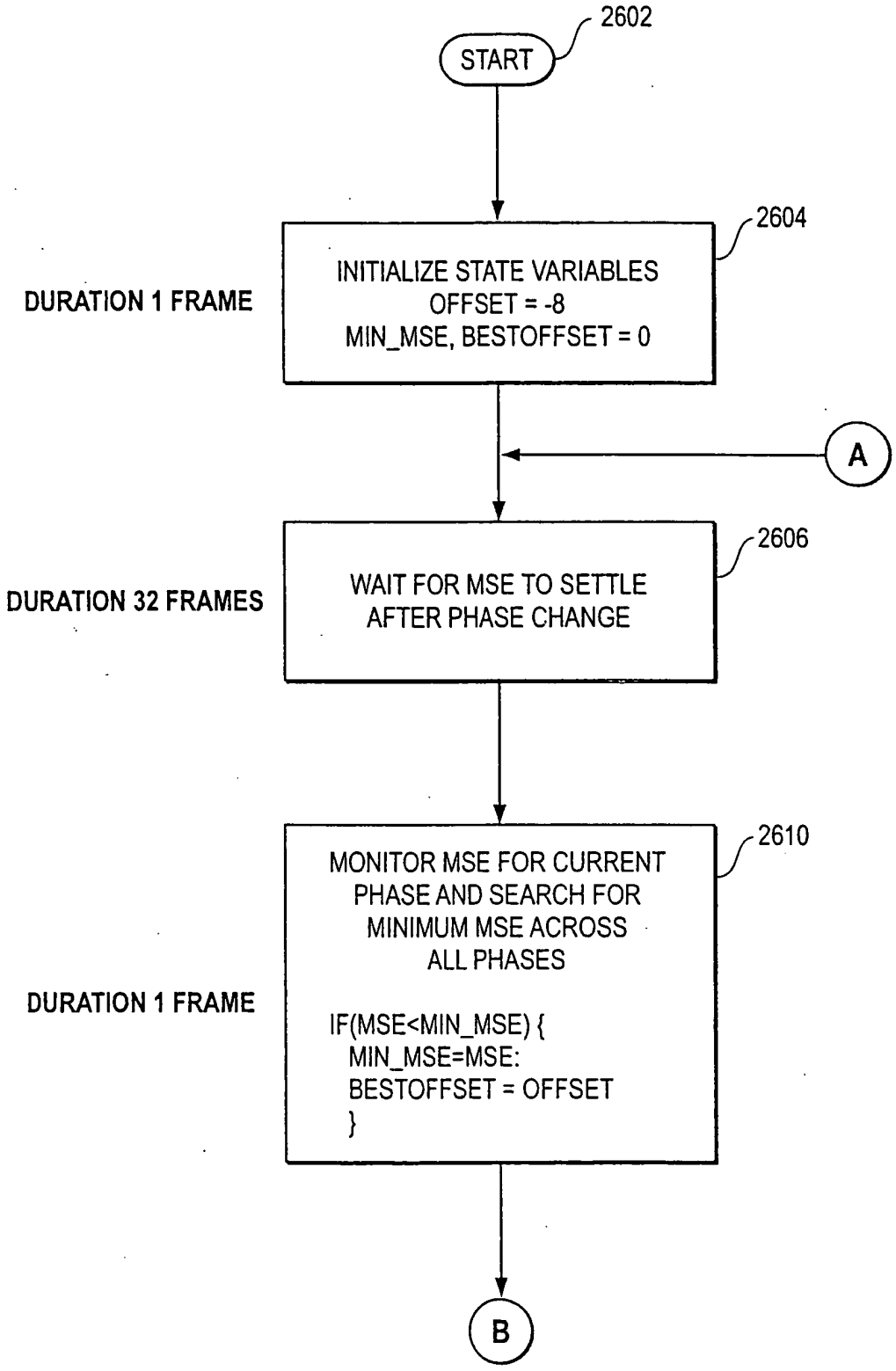

2602
START
2604
INITIALIZE STATE VARIABLES
OFFSET = -8
MIN_MSE, BESTOFFSET = 0
DURATION 1 FRAME
A
2606
WAIT FOR MSE TO SETTLE
AFTER PHASE CHANGE
DURATION 32 FRAMES
2610
MONITOR MSE FOR CURRENT
PHASE AND SEARCH FOR
MINIMUM MSE ACROSS
ALL PHASES
IF(MSE<MIN_MSE) {
MIN_MSE=MSE:
BESTOFFSET = OFFSET
}
DURATION 1 FRAME
B

FIG. 26B

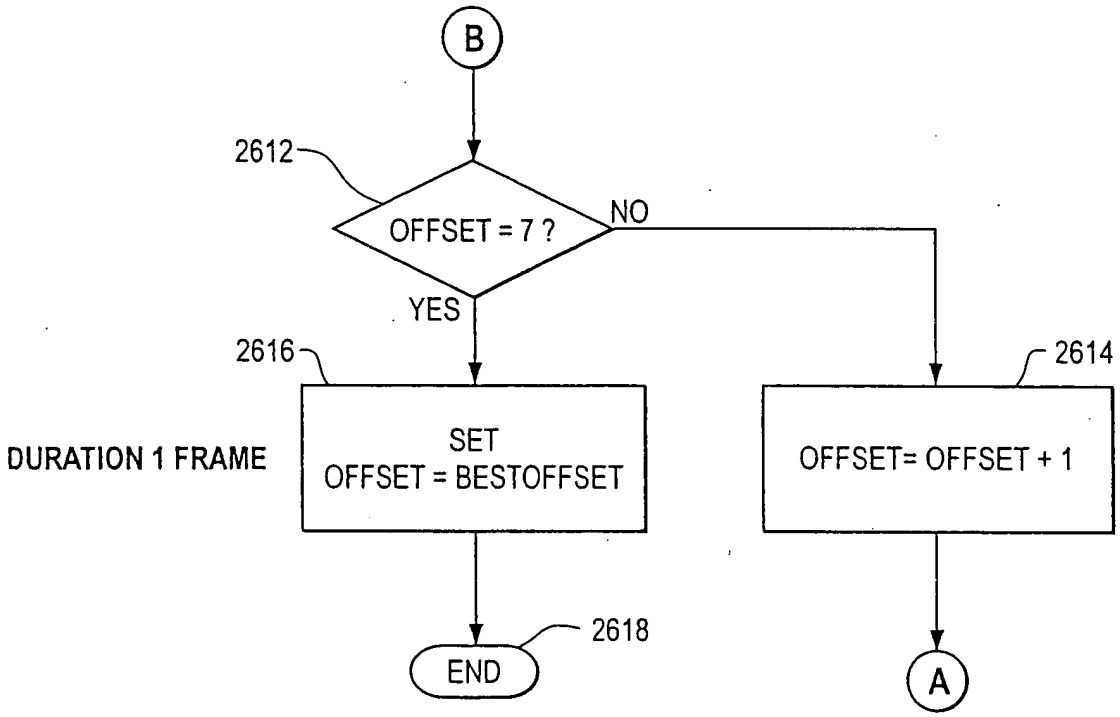
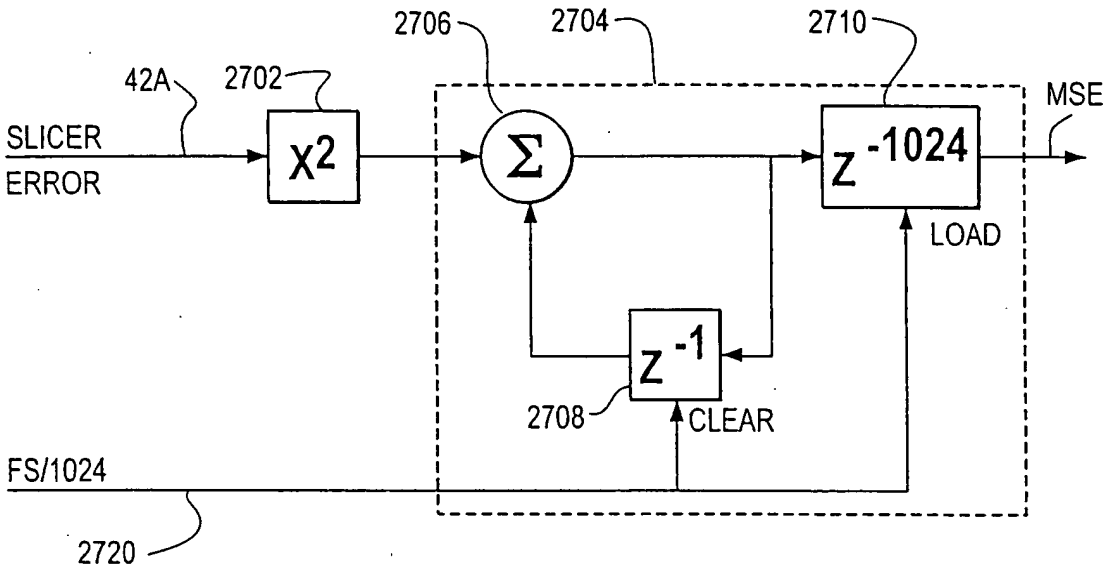

B
2612
OFFSET = 7 ?
NO
YES
2616
2614
DURATION 1 FRAME
SET
OFFSET = BESTOFFSET
OFFSET= OFFSET + 1
2618
END
A

FIG. 27


2706
2704
2710
42A
2702
MSE
SLICER
ERROR
X2
Σ
Z -1024
LOAD
Z -1
2708
CLEAR
FS/1024
2720

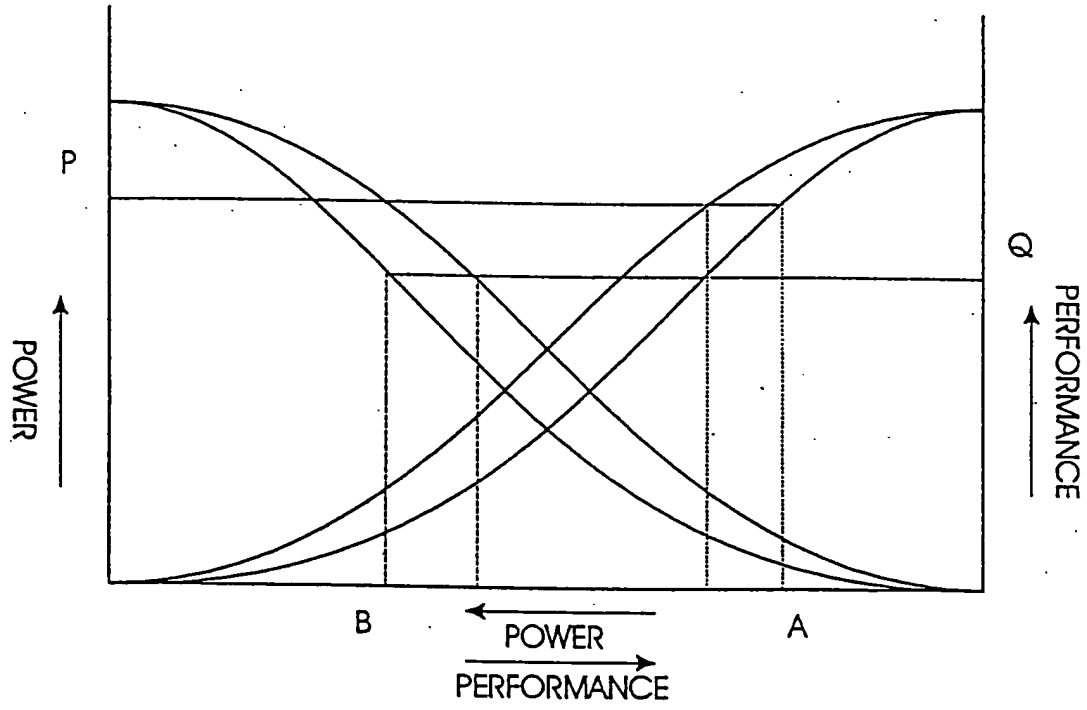


FIG. 28

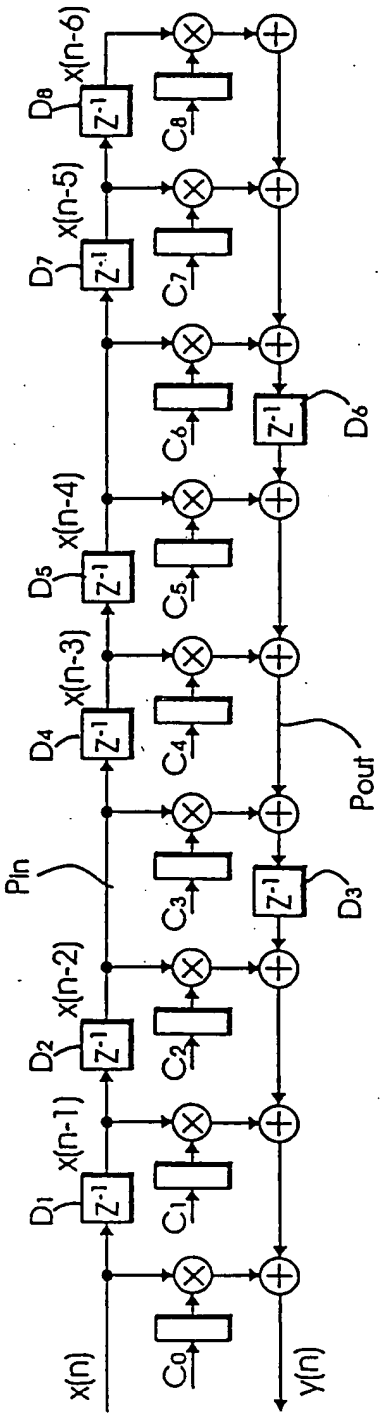


FIG. 29A

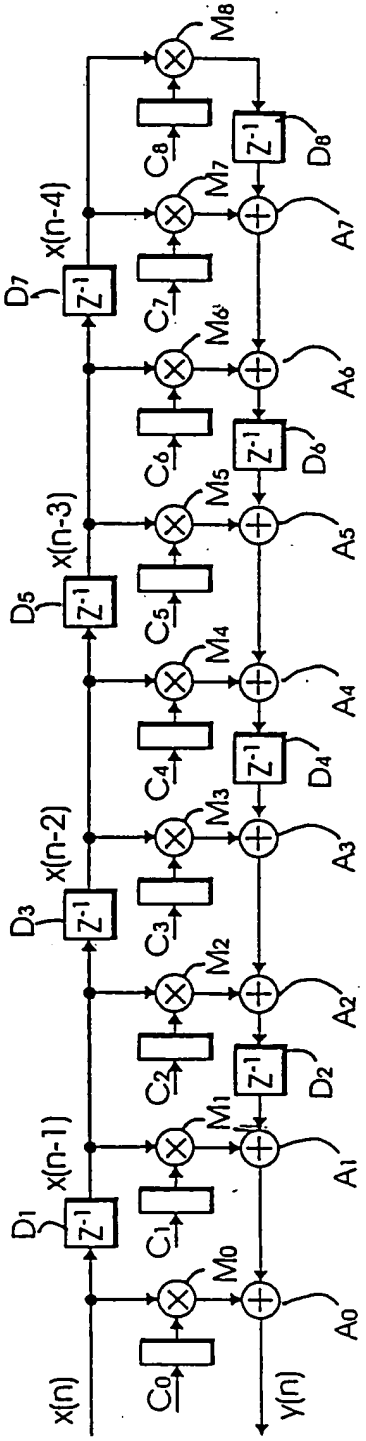


FIG. 29B

TITLE: MULTI-PAIR GIGABIT ETHERNET
TRANSCEIVER HAVING ADAPTIVE ...
INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

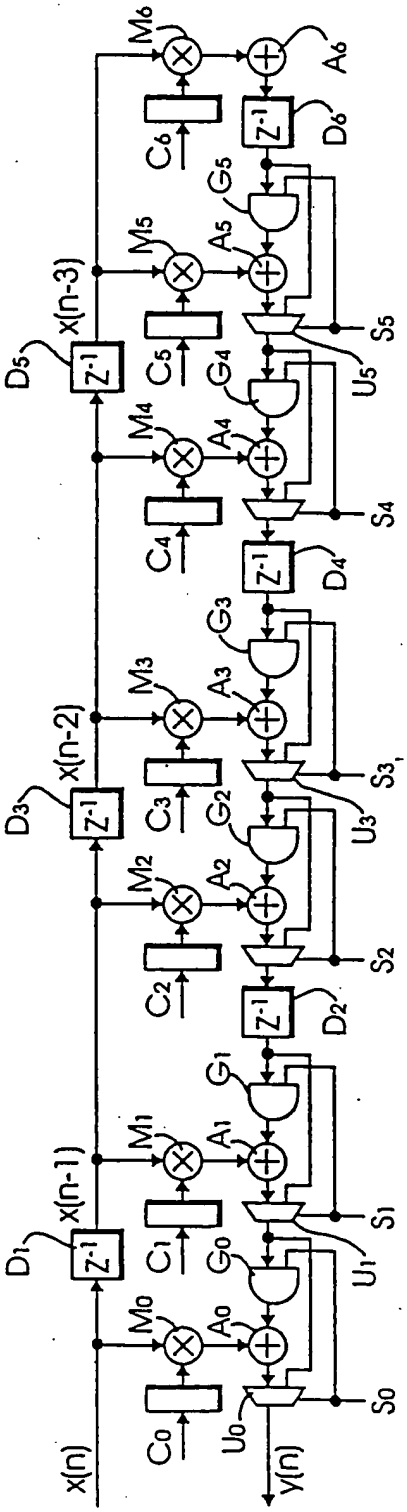


FIG. 29C

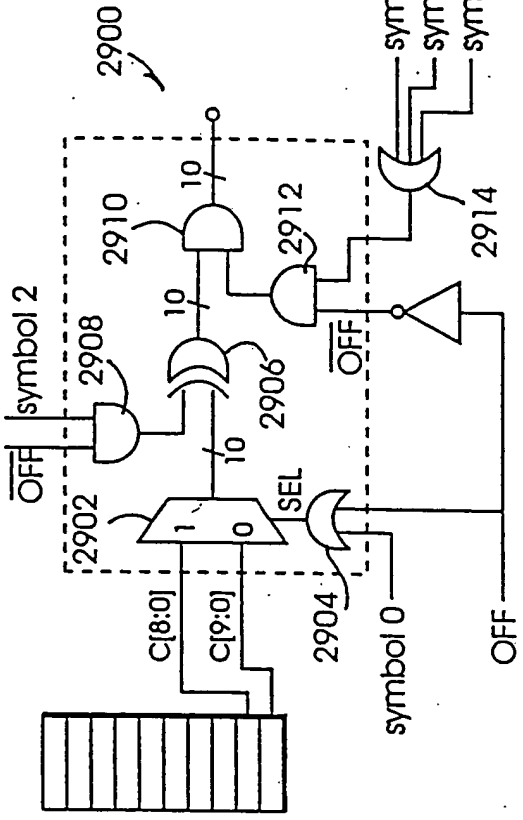


FIG. 29D

TITLE: MULTI-PAIR GIGABIT ETHERNET TRANSCEIVER HAVING ADAPTIVE ...
INVENTOR: AGAZZI
APPLICATION NO.: UNASSIGNED,
CONF. NO. ; DOCKET NO. 13439US06
ATTORNEY: JAW, PHONE: 312-775-8000

FIG. 30

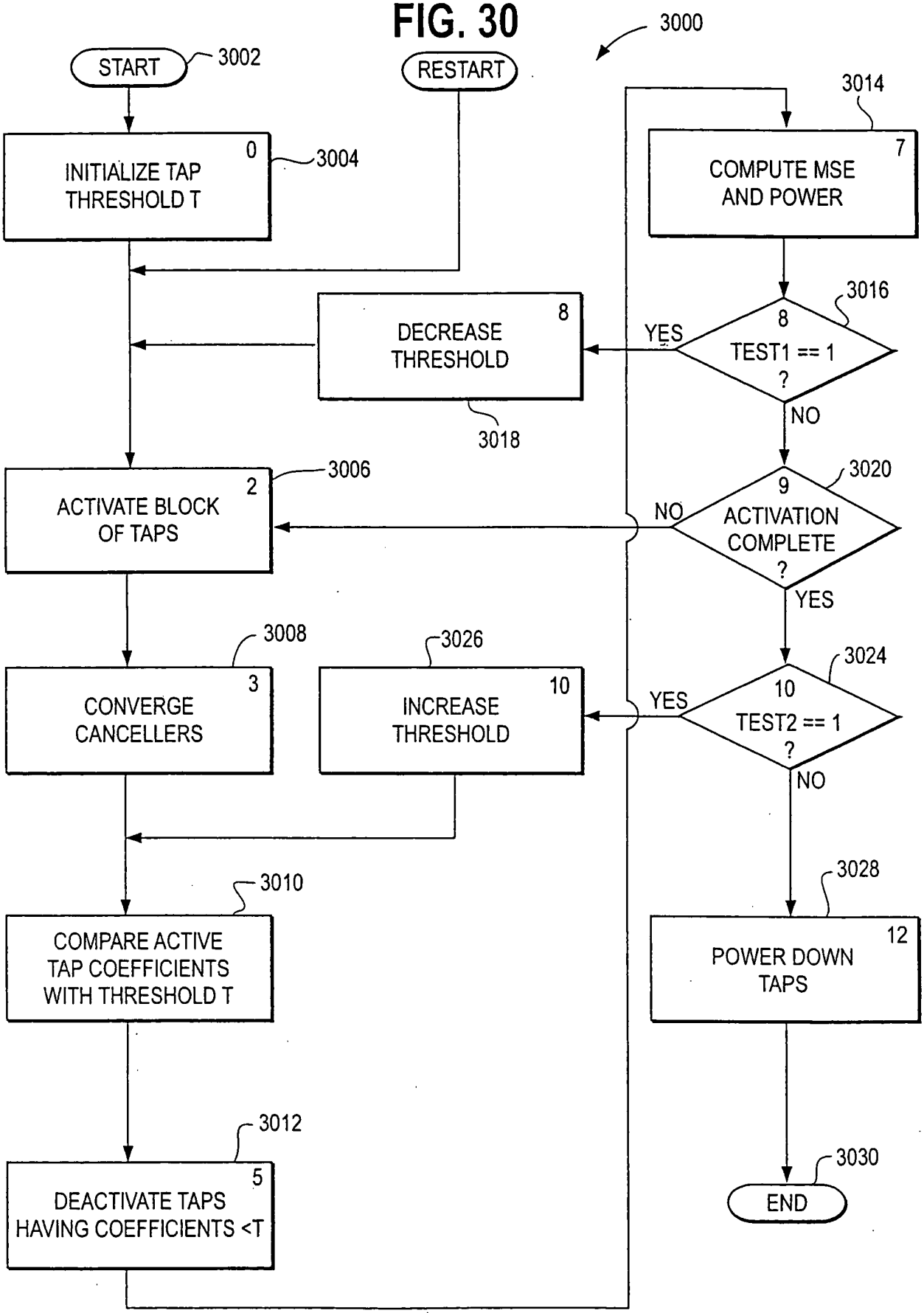


FIG. 31

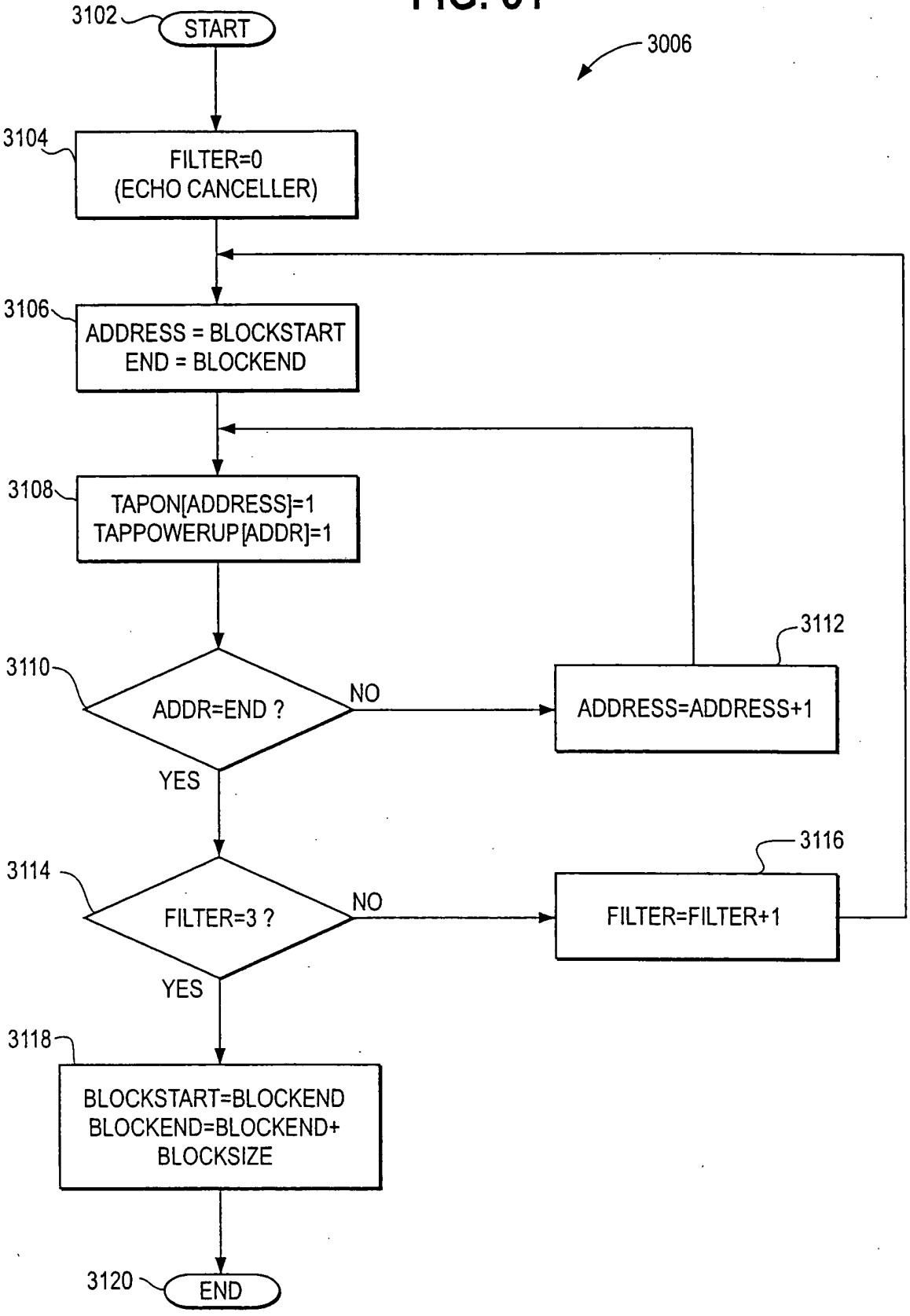

3102
START
3006
3104
FILTER=0
(ECHO CANCELLER)
3106
ADDRESS = BLOCKSTART
END = BLOCKEND
3108
TAPON[ADDRESS]=1
TAPPOWERUP[ADDR]=1
3110
ADDR=END ?
NO
3112
ADDRESS=ADDRESS+1
YES
3114
FILTER=3 ?
NO
3116
FILTER=FILTER+1
YES
3118
BLOCKSTART=BLOCKEND
BLOCKEND=BLOCKEND+
BLOCKSIZE
3120
END

FIG. 32

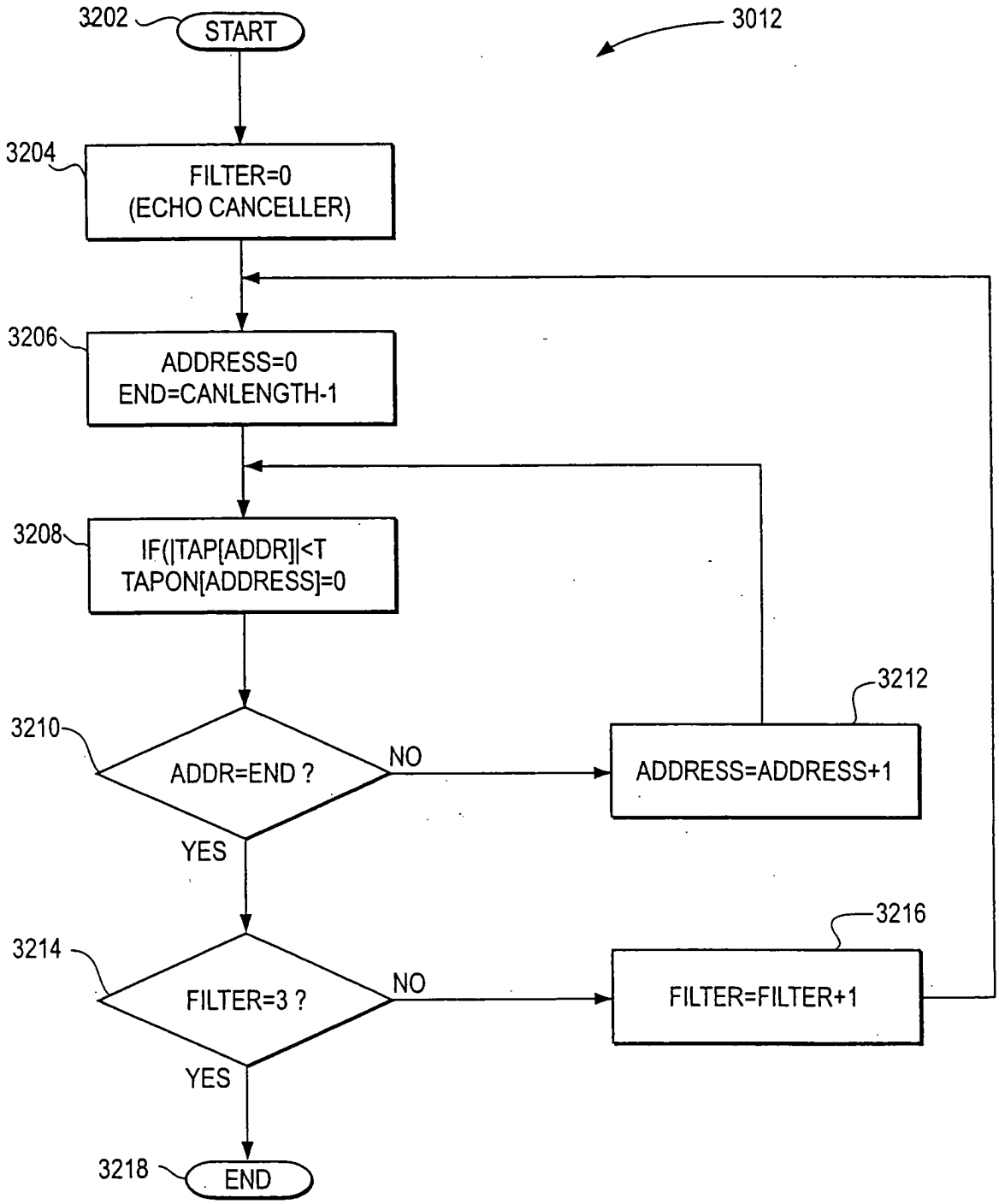

3202
START
3012
3204
FILTER=0
(ECHO CANCELLER)
3206
ADDRESS=0
END=CANLENGTH-1
3208
IF(|TAP[ADDR]|<T
TAPON[ADDRESS]=0
3212
3210
ADDR=END ?
NO
ADDRESS=ADDRESS+1
YES
3216
3214
FILTER=3 ?
NO
FILTER=FILTER+1
YES
3218
END

FIG. 33

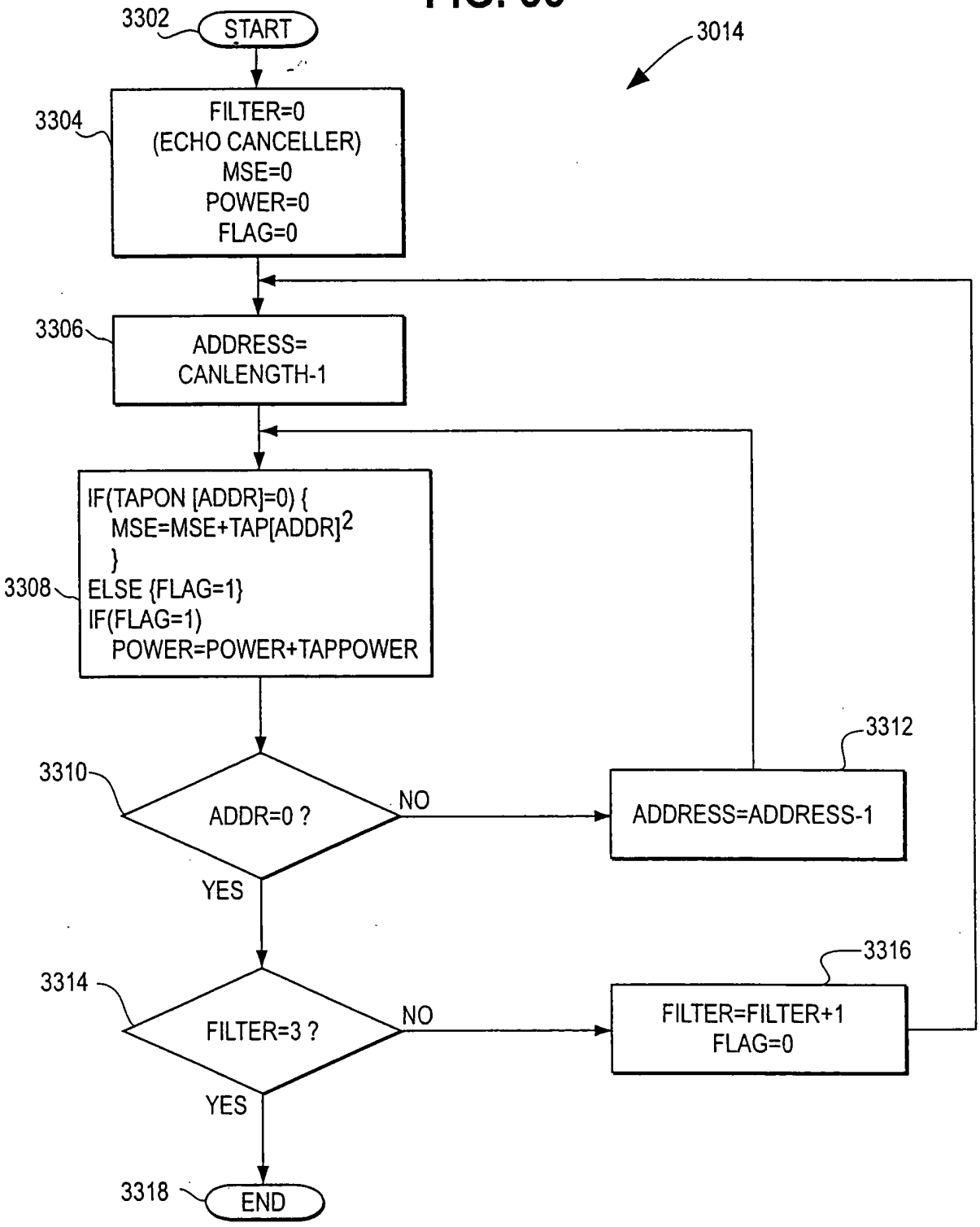

3302
START
3014
3304
FILTER=0
(ECHO CANCELLER)
MSE=0
POWER=0
FLAG=0
3306
ADDRESS=
CANLENGTH-1
3308
IF(TAPON [ADDR]=0) {
MSE=MSE+TAP[ADDR]2
}
ELSE {FLAG=1}
IF(FLAG=1)
POWER=POWER+TAPPOWER
3310
ADDR=0 ?
NO
3312
ADDRESS=ADDRESS-1
YES
3314
FILTER=3 ?
NO
3316
FILTER=FILTER+1
FLAG=0
YES
3318
END

FIG. 34

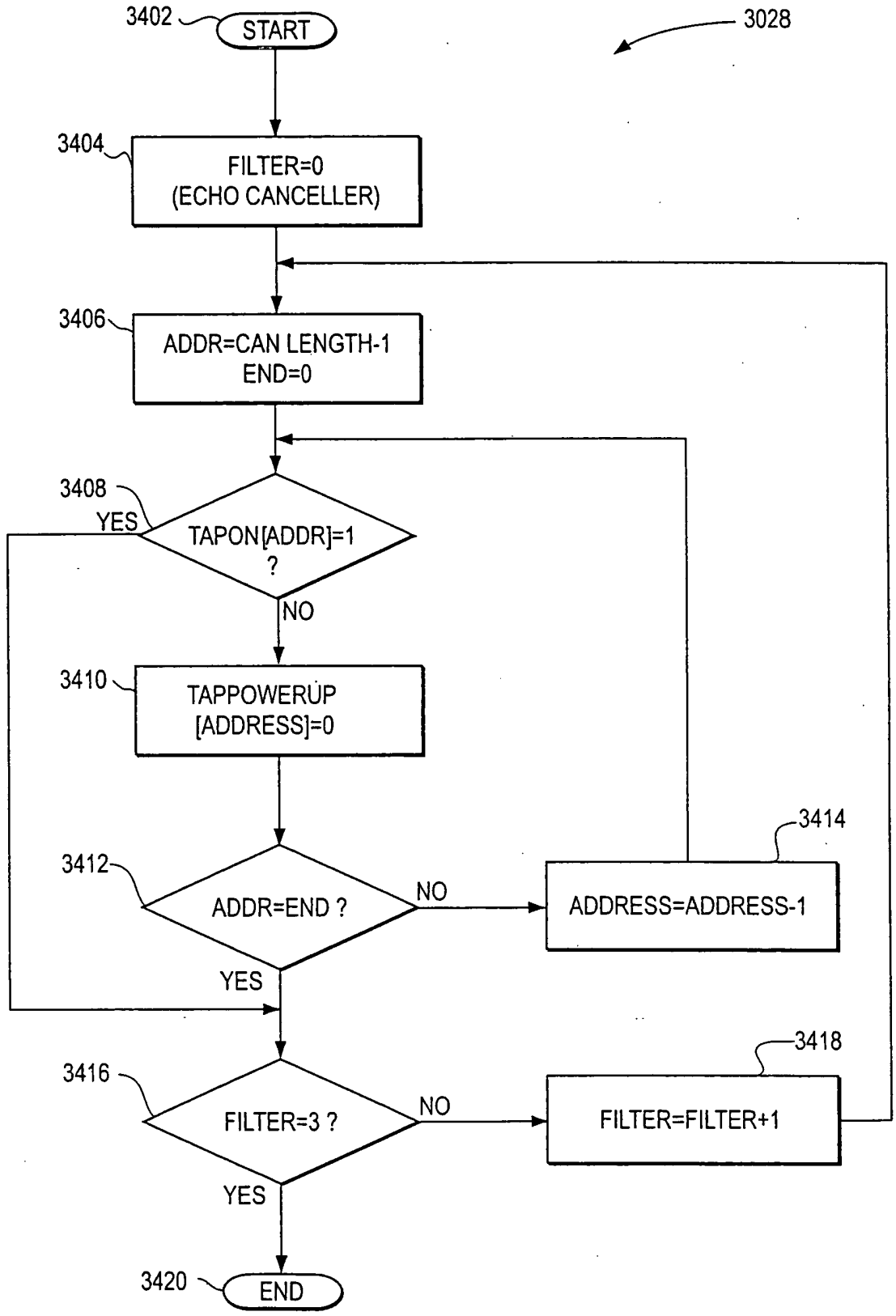

3028
3402
START
3404
FILTER=0
(ECHO CANCELLER)
3406
ADDR=CAN LENGTH-1
END=0
3408
YES
TAPON[ADDR]=1
?
NO
3410
TAPPOWERUP
[ADDRESS]=0
3412
ADDR=END ?
NO
3414
ADDRESS=ADDRESS-1
YES
3416
FILTER=3 ?
NO
3418
FILTER=FILTER+1
YES
3420
END

FIG. 35

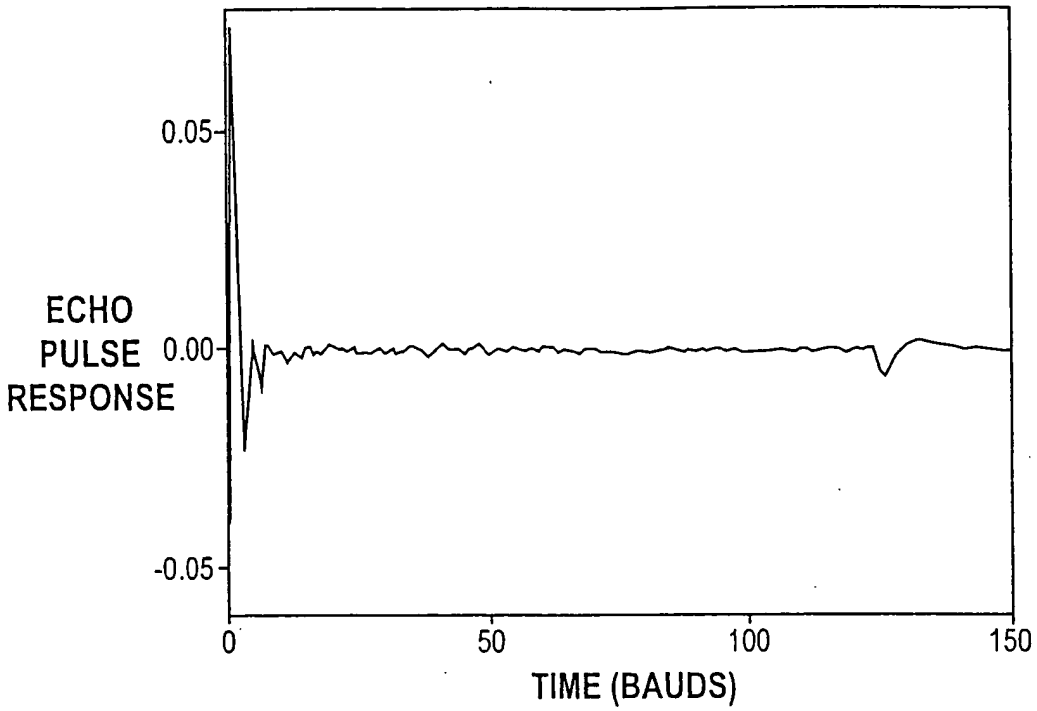

ECHO
PULSE
RESPONSE
0.05
0.00
-0.05
0
50
100
150
TIME (BAUDS)

FIG. 36

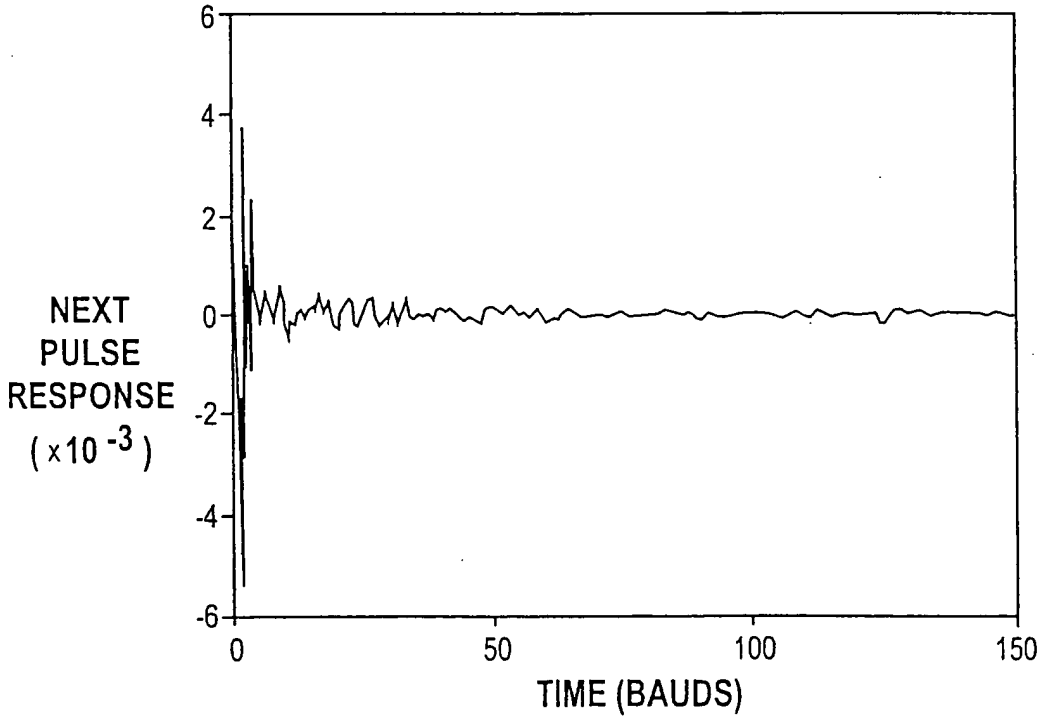

NEXT
PULSE
RESPONSE
(x10 -3)
6
4
2
0
-2
-4
-6
0
50
100
150
TIME (BAUDS)

FIG. 37A

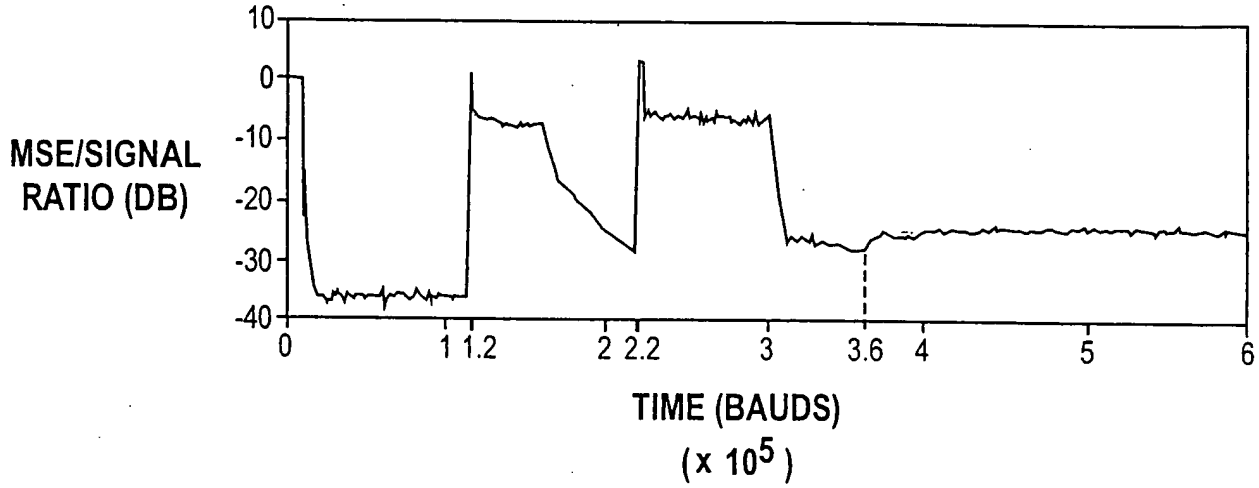


FIG. 37B

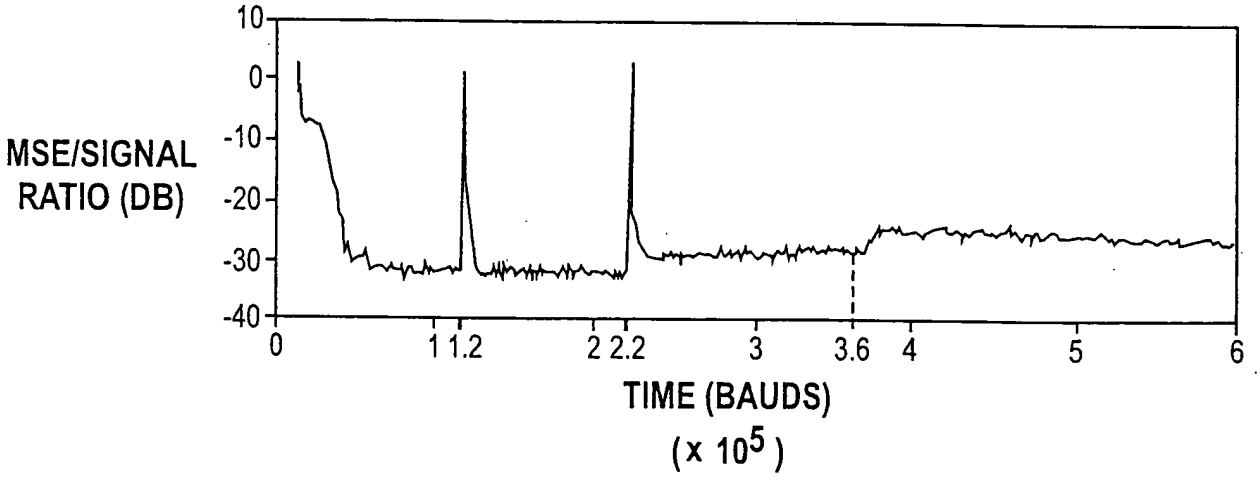


FIG. 38A

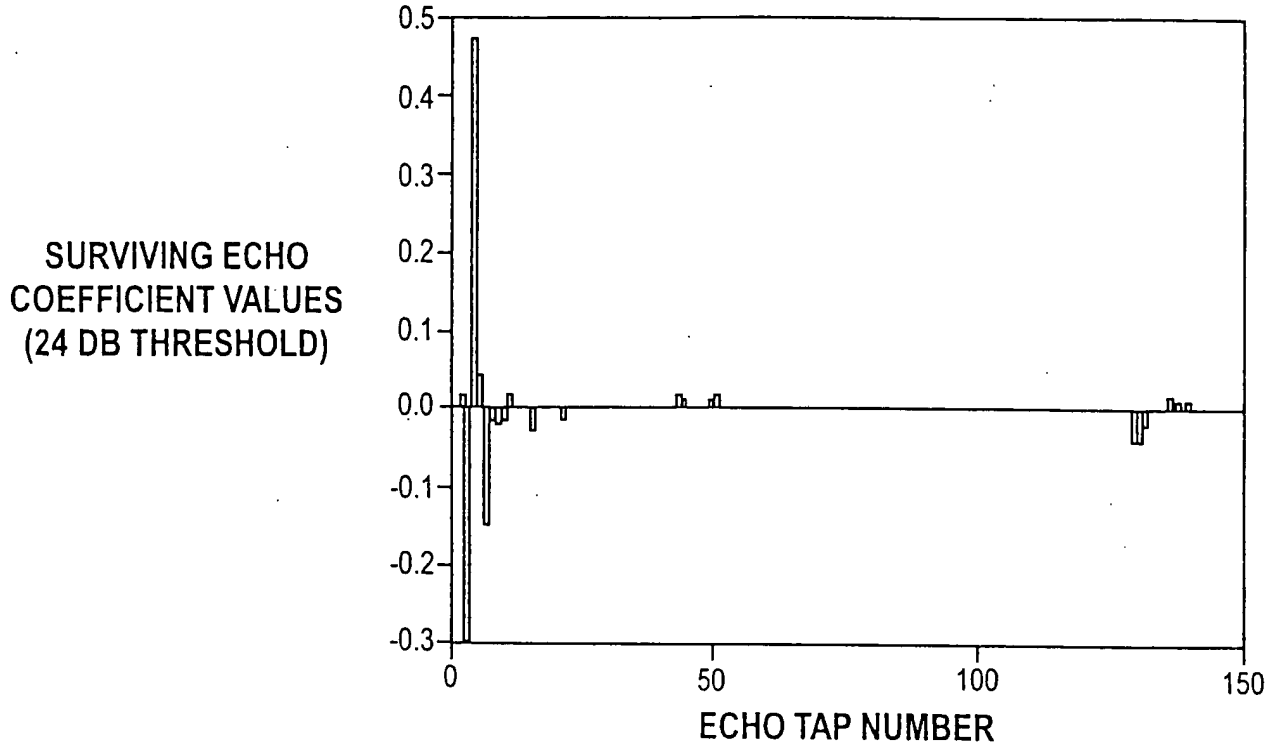
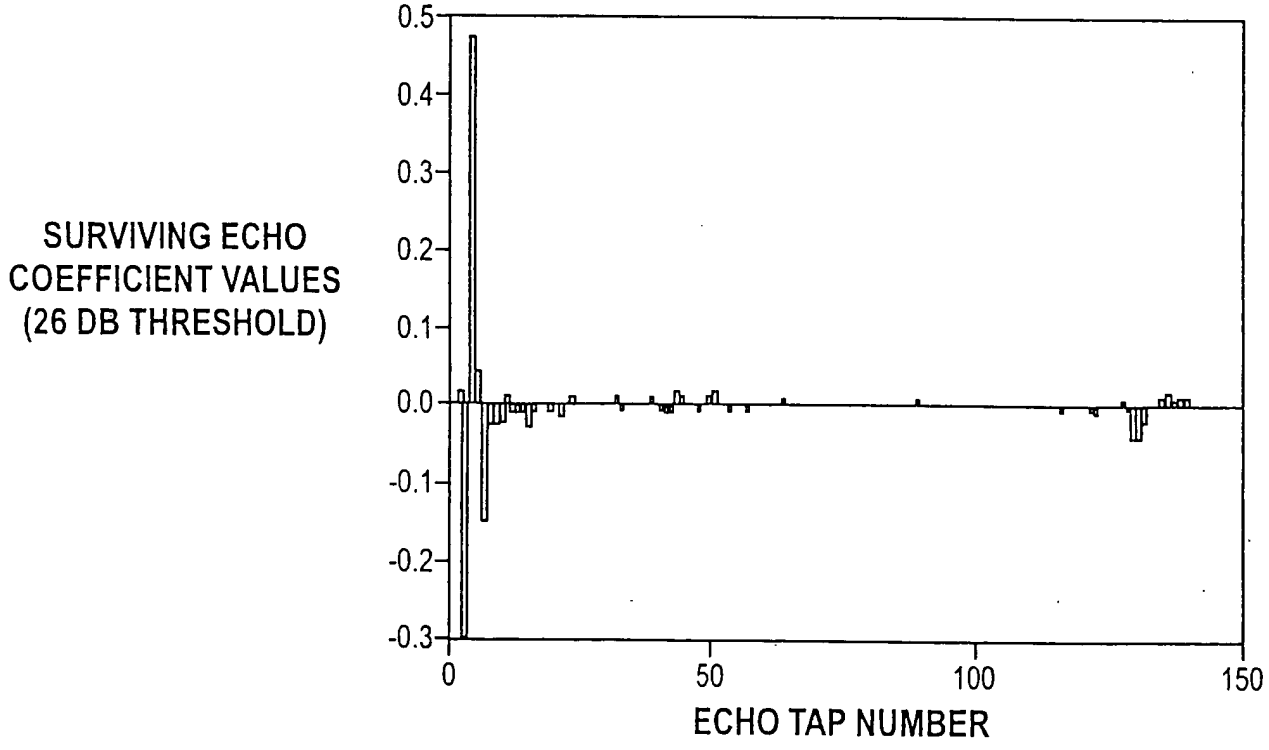


FIG. 38B



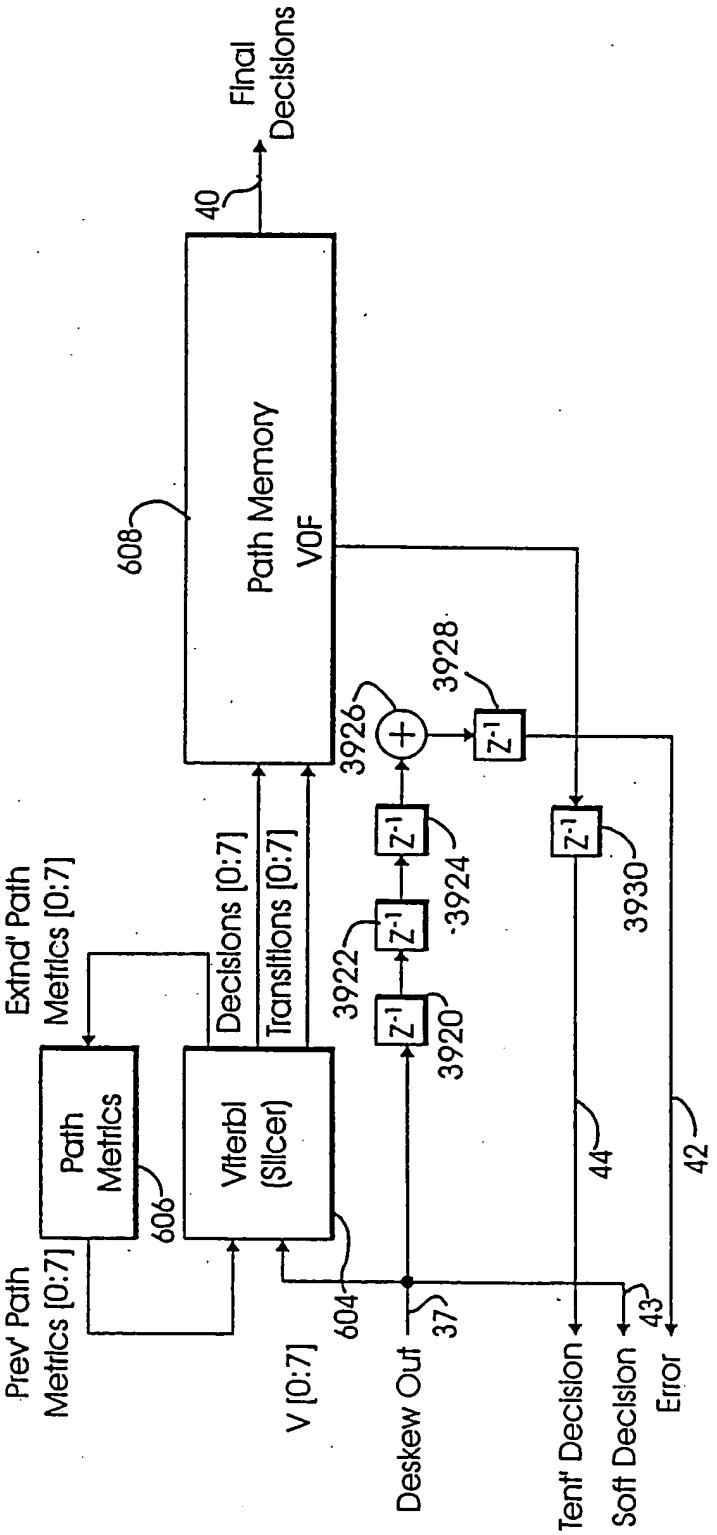

Final Decisions
40
608
Path Memory
V0F
3928
3926
Z-1
3924
3922
3920
3930
Extnd' Path Metrics [0:7]
Decisions [0:7]
Transitions [0:7]
Path Metrics
606
Viterbi (Slicer)
Prev' Path Metrics [0:7]
V [0:7]
604
Deskew Out
37
Tent' Decision
Soft Decision
Error
44
42
43

FIG. 39

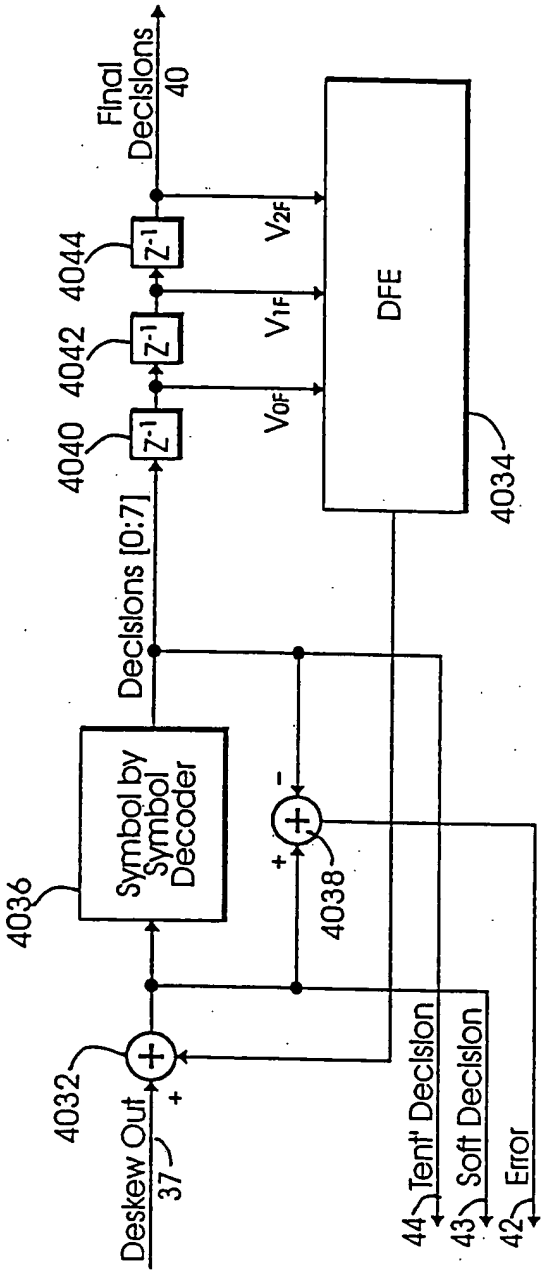

Final Decisions
40
4044
4042
4040
Z-1
Z-1
Z-1
V2F
V1F
V0F
DFE
4034
Decisions [0:7]
Symbol by Symbol Decoder
4036
4038
4032
Deskew Out
37
Tent' Decision
Soft Decision
Error
44
43
42

FIG. 40